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Linking Public Health and Community Design Through Green Infrastructure

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Dedication

In memory of Mabel Futrell Martin

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Linking Public Health and Community Design Through Green Infrastructure

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The link between community design and public health has gained prominence in recent years as solutions are sought for chronic health problems attributed, in part, to environmental conditions and physical inactivity. In response to these intersecting challenges, the connectivity of a green infrastructure system may offer a dynamic solution toward healthy community design in providing opportunities for increased levels of physical activity. This dissertation explores how green infrastructure can work to bridge planning and public health concerns through physical activity at the municipal scale.

Using qualitative comparative case study methods, green infrastructure for physical activity is explored through existing policies, infrastructure, and strategies for implementation in four cities known for 'green' initiatives – Austin, Texas; Denver, Colorado; Louisville, Kentucky; and Portland, Oregon. My primary research question focuses on how green infrastructure can serve as a bridge between planning and public health to realize infrastructure that provides for human physical activity at the municipal scale. Through a lens of critical pragmatism, three sources of data comprise the investigation through a normative framework: 1) Review and evaluation of municipal comprehensive plans and functional master plans for parks, stormwater management, and green infrastructure/greenprinting; 2) a content analysis of a significant project in each city utilizing two audit tools for post-occupancy evaluation in terms of non-motorized modes for connectivity, integration, and multi-functionality; and 3) forty-four semi-

structured interviews with agency staff, professional consultants, and developers participating in the process at the project and municipal levels. Emerging patterns from analysis were then compared across the four cities.

Findings suggest projects demonstrate connectivity in complete and well-connected routes for both pedestrian and bicycle circulation, yet the politics of maintenance challenge innovative solutions. Broad goals of municipal plans were not easily translated into project implementation, while public health involvement for the projects was intent on removal of environmental contaminants from previous land uses. The power of these innovative projects to test the regulatory framework with ecological infrastructure solutions reveals the complexities of overlapping jurisdictional agencies and disciplinary interests. The use of storytelling and project precedents serve an important role in understanding the ‘messiness’ of navigating through the regulatory process, and combined with technical knowledge provide a knowledge–action–knowledge sequence to advance both green infrastructure theory and practice.

This research highlights the emerging opportunities for incorporating normative values of health through urban ecological infrastructure. It illustrates the collaborative roles of key participants and their successes in crossing disciplinary boundaries to pursue collaborative strategies for multi-functional landscapes that can provide an array of health benefits, including physical activity. The incorporation of health in planning and design and the interaction with public health interests are key components to the future of ecosystem services.

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Chapter One: Introduction

Healthy cities promote healthy individuals toward a sustainable future. The opportunity to thrive in social and physical environments depends on access to clean water, clean air, adequate food, and places to live, work, and play (Wernham and Teutsch 2015). Infrastructure constitutes the underlying foundation in both the natural and the built environments in providing facilities to sustain health and support growth. In this context, the built environment can be defined as physical "settings designed, created, and maintained by human efforts" (Frumkin et al. 2011, 5) such as buildings, public spaces, and infrastructure systems. Several types of infrastructure support life in the city, such as physical, social, and economic. This study focuses on physical infrastructure in the promotion of health through access to and facilities for human physical activity–bodily movement that uses energy and is positively correlated with physical fitness (Caspersen et al. 1985).

Today's infrastructure is inadequate to meet the demands of a growing urban population. The Brookings Institute predicts more than 40% of the built environment in the United States will be new or need to be replaced between 2000 and 2030 (Nelson 2004). Compounding these challenges, investment in infrastructure has largely focused on the conventional solutions of gray infrastructure, constructing 'pipes and poles,' most often in single purpose corridors (Aquino et al. 2011). These corridors of resource consumption affect land use patterns and direct areas for development.

As cities grow, significant areas of land are converted for urban development (Ahern et al. 2014). Pressures for land development intensify, and competing interests for land development and conservation often result in fragmenting both the community and its open space (Benedict and McMahon 2006). Suburban sprawl has been a product of this accelerated urban growth, placing a burden on existing infrastructure and requiring improved and expanded system capacity for transportation, communication, and utilities (Frumkin et al. 2004). Access to and availability of facilities for physical activity such as cycling and walking, are adversely impacted by the effects of sprawl (Frumkin et al. 2004).

In contrast to the fragmented land use patterns resulting from sprawl, an ecological framework utilizing green infrastructure where natural pervious areas or those constructed to mimic natural conditions, offers a foundation for urban form and growth. In this context, it guides decisions for sustainable land use that balance conservation and development interests (Eisenman 2013, 288). Some innovative solutions using green infrastructure have been introduced in an effort to promote sustainability through multi-functional landscapes. These works combine the integration of and interaction between functions, yet investment in green infrastructure lags behind that of conventional gray infrastructure (Wenk 2002). Often, the costs of infrastructure are considered without evaluating the health benefits and the costs associated with those choices (Frank et al. 2003). The needs for open space are also challenged as urban development continues at an accelerated rate, reducing opportunities for access to areas for both physical activity and contact with nature. My dissertation explores the opportunities and limitations of a green infrastructure framework to promote human physical activity.

1.1 Issues in the Built Environment–Physical Inactivity and Green Infrastructure

Physical inactivity continues to increase in a technological age where adults have employment that is largely sedentary (compared to manual labor jobs). Only six states

(Illinois, Hawaii, Massachusetts, Mississippi, New York, and Vermont) require physical education for school children in all grades K-12.[1] This inactivity has reached pandemic proportions (Kohl et al. 2012). Chronic illnesses have been linked to obesity caused in part by physical inactivity, such as cardiovascular disease and type two diabetes. In response to these problems, research has examined a wide range of populations to explain the effect that community environment has on physical activity, and determine strategies to increase opportunities for such activity (Brownson et al. 2009). Concentration of physical activity research lies in two domains–bicycling and walking. Topics include both recreation and active transportation such as: Safe Routes to School, parks and open space access and use patterns, and neighborhood walkability. Evidence-based recommendations from such studies inform both decision-makers and the general public.[2]

In recent years, there has been an increase of physical activity research and promotion focusing on the impacts of the built environment. By only considering the built environment, as opposed to the natural environment, many opportunities may be missed to investigate systematic ways to provide a cohesive network for physical activity. Work to date has been inadequate to address comprehensive community concerns of social, physical, mental, environmental, and economic impacts that physical inactivity has on the well-being of its citizens (Jackson and Sinclair 2012). Planners and designers formulate policy and develop design guidelines to encourage walkability and active transportation for programs such as Safe Routes to School (Boarnet et al. 2005), while those in public health fields produce quantitative studies to document individual

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[1] "Shape of the Nation Report: Status of Physical Education in the USA," National Association for Sport and Physical Education & American Heart Association, 2012.

[2] www.activelivingresearch.org

behavioral interventions and environmental attributes that influence such behavior. Multiple and differing academic perspectives, translating across spatial scales, and specific disciplinary approaches have failed to converge in a way that could lead to a more holistic understanding of physical activity research in its application to practice. As city leaders recognize the need for physical activity to be part of a solution for a sustainable environment, there is a need for more comprehensive strategies to provide adequate infrastructure to support opportunities for physical activity.

1.2 Green Infrastructure as System–An Upstream Approach to Public Health

The sustainability of urban development patterns seeks to balance interests for environmental resources, social equity, and economic growth (Campbell 1996). To incorporate the concept, a systems approach has been advocated to relate the interdependencies of community sub–systems for health such as food, housing, transportation (Capon and Thompson 2011, 373), and recreation. Incorporating green infrastructure offers a foundation to relate these interdependencies to promote both ecological and human health. For the purposes of this study, green infrastructure is defined as interconnected network of green spaces across spatial scales, composed of both human-made (engineered) and natural features (Benedict and McMahon 2006; Williamson 2003; Dunn 2010) that provide goods and services that directly or indirectly benefit humans (Austin 2014, 92).

Green infrastructure relates public health activities with relevant ecological knowledge (Tzoulas and Greening 2011) at city, district, neighborhood, and individual levels. Examples range from Ecohealth at the city scale, combining ecology in habitat creation and restoration with ecosystem management, to creation of interconnected networks of urban green space for trails and play areas at the city and neighborhoods levels (Tzoulas and Greening 2011). Using a multi-scalar approach could engage planners with other disciplines in working through complex decisions for urban growth to influence positive health outcomes (Tzoulas et al. 2007, 373). Rather than relying on individual efforts in each sub-system, synergistic methods could incorporate physical activity as part of a healthy community network, providing the opportunity to work across disciplinary and organizational boundaries and re-conceptualize fragmented single purpose infrastructures, such as roads and utility systems, as components of an integrative community infrastructure.

Integrated with urban ecosystems that "include both nature and humans in a largely human built environment,"[3] green infrastructure can make a significant upstream contribution to public health by centering on the social and environmental conditions that promote health (Tzoulas and Greening 2011, 263). Establishing a foundation for sustainable land use and development through the natural resources to support human systems, green infrastructure provides benefits and services that allow people to gain health benefits including physical activity. My dissertation integrates these perspectives for multi-functional landscapes as part of a framework that bridges disciplines to seek holistic solutions for community planning and design.

1.3 Study Purpose, Goals, and Motivation

The purpose of this study is to explore green infrastructure and its potential to support physical activity by identifying and evaluating current strategies and best

[3] http://sciencenetlinks.com/lessons/urban-ecosystems-1/

practices that promote physical activity at the municipal scale. Although many components such as social, cultural, and economic factors contribute to green infrastructure and physical activity, my research focuses on the physical planning and design of such infrastructure. Identifying planning and design strategies and performance measures can inform development of local policies and codes to support public health goals for physical activity. My aims for this study are to make a contribution to a research agenda that benefits both academia and practice in three ways: 1) link plans to outcomes, not just as documents, but processes of transforming the goals of municipal policies to application in project design and implementation relative to green infrastructure and physical activity; 2) understand the level of interaction of public health with planning and design through selected projects; and 3) bridge planning and design with public health using green infrastructure as a unit of analysis. A critical target in this work is the municipal scale, particularly the relationship between significant or 'signature projects' that demonstrate the qualities of complex aggregated, performative landscapes, and the opportunities and barriers that exist for these projects to serve as catalysts to affect change citywide. In this context, a signature project demonstrates innovative and creative design solutions responsive to urban conditions.

The motivation for my dissertation emerged from years of professional experiences on interdisciplinary and multidisciplinary projects as a practicing landscape architect and planner. Many of these efforts involved green infrastructure components and/or facilities promoting physical activity. Working through the tenets of varying professional perspectives and disciplinary jargon during a project's iterative stages of planning and design presented challenges, yet produced several innovative interdisciplinary solutions in support of physical activity. Moving forward thinking integrative concepts through the regulatory permitting and approval process proved to be time consuming and difficult. The jurisdictions of applicable federal, state, and local agencies overlapped–often with differing permit requirements. Specificity of regulations constrained the realization of visionary policy goals. Pushing the boundaries of the regulatory framework required artful skills and tenacity to bring these interdisciplinary projects to fruition.

Every project has its own story to tell, with cultural and political circumstances unique to its particular context. The stories of projects and the actors involved provide meaningful information in a collective need for knowledge to advance both research as well as practice. By exploring the selected "green" cities and respective signature projects, I investigate questions that I could not explore as a practitioner–where once a project was completed there was rarely time to adequately document its impact, performance, or significance to its chosen location.

1.4 Research Questions

My central research question is how can green infrastructure serve as a bridge between planning and public health to create infrastructure and opportunities for physical activity at the municipal scale. Four thematic questions are posed relative to the central research question:

1) **Scale:** Did planning and design strategies and best practices of a signature project translate scale from site to city? What were the influences across cities?
2) **Health:** Did the green infrastructure project consider health in planning, design, and implementation? If so, how?

3) **Power and Collaboration:** What was the role of political power in the process, and how did key actors collaborate to affect change in terms of city policies and codes?

4) **Measurement:** What performance indicators or relative measurements should be used to monitor success from the perspectives of planning, design, and public health?

1.5 Outline of Research and Findings–Organization of Document

My analysis utilizes a comparative case study approach to explore the potential for green infrastructure that supports physical activity in four cities known for innovative strategies: Austin, Texas; Denver, Colorado; Louisville, Kentucky; and Portland, Oregon. Chapter Two focuses on topical literature in the areas of green infrastructure and physical activity, particularly as each relates to community planning, public health and urban design. In Chapter Three, I present an overview of my research design and theoretical framework. Chapter Four describes the context of each of the case study cities, foregrounding the analysis by city and project respectively, in Chapters Five through Eight. Finally, Chapter Nine provides a summary of findings and directions for future research.

1.6 Operational Definitions

The following list provides operational definitions for key terms used in my dissertation.

Best management practices–measures designed to effectively prevent or reduce adverse impacts to water quality and quantity generally attributed to land use practices and development. Practices may be practical management or structural changes. Examples include but are not limited to bioretention, green roofs, bioswales, rain gardens, stream buffers, street trees, urban forests, porous pavement, and/or constructed wetlands. (after American Rivers, accessed June 2, 2015: http://www.americanrivers.org/green-infrastructure-training/resources/best-management-practices

Built environment–broadly includes land use patterns, the transportation system, and design features that together provide opportunities for travel and physical activity. Land use patterns refer to the spatial distribution of human activities. The transportation system refers to the physical infrastructure and services that provide the spatial links or connectivity among activities. Design refers to the aesthetic, physical, and functional qualities of the built environment, such as the design of buildings and streetscapes, and relates to both land use patterns and the transportation system. Accessed December 1, 2013 from: http://onlinepubs.trb.org/onlinepubs/sr/sr282.pdf

Community–generally refers to local political jurisdictions, including city, town or village; in certain circumstances may consist of a sub-area of a city consisting of residential, institutional and commercial uses that share a common identity (Davidson and Dolnick 2004).

Community design–process of giving form in terms of both aesthetic qualities and function, at the municipal level. Considerations for design include: mass, location and various urban components combining elements of landscape architecture, urban design and architecture. Accessed December 1, 2013 from: http://www.bephc.gatech.edu/glossary/community-design

Comprehensive Plan–a long-range plan that includes a vision adopted by the community and the technical and political basis for growth management and other local government programs (Randolph 2004, 145).

Design–a problem solving process in which there is a response to a set of existing conditions (a problem) to which a new set of conditions (a solution) would be more desirable. Aspects of the environment that should be included in design involve form; order; functionality in the spaces that facilitate various uses; movement through space and time; context, in that form and meaning must be connected; and aesthetics, creating spaces of beauty (Ching 2007; Vroom 2006). In landscape architecture, it typically "links a site, a location and a patron" (Vroom 2006, 93).

Design strategy–a set of decisions for design, which drive proposed components by purpose and intent, offering clarity, guidance and direction to reach a solution. Strategy forms a contingent path through a decision tree to determine course of action (Hopkins 2001).

Functional Plan–a plan that addresses a single topic covering an entire planning area, including but not limited to transportation, infrastructure, natural environment, parks and recreation, housing, and economic development (after Randolph 2004).

Green infrastructure–interconnected system of green space that conserves natural values and functions of ecosystems, and provides goods and services to the human population associated with such ecological framework for community sustainability. (after Benedict and McMahon 2002).

Infrastructure–the underlying foundation of basic installations and facilities on which a city depends for continuance and growth (paraphrased from Webster collegiate dictionary, eleventh edition).

Multi-functionality–an integration of and interaction between functions; more specifically, the combination of integrating the spatial patterning of land uses and activities, and interaction of functions and components to "serve the requirements of local economies, the environment and social objectives" (Gallent et al. 2004; Roe and Mell 2013).

Nature–a great variety of outdoor settings that contain substantial amounts of vegetation (Kaplan et al. 1998, 1).

Nature contact–personal human experience of viewing natural scenes, being in natural environments of public space and/or urban park settings.

Non-regulatory tools–measures for land use control include land acquisition, tax policies and use of infrastructure development to direct timing and location of development (Randolph 2004, 142).

Performative landscape–characterized by processes of functional ecological regeneration and productivity (Stilgenbauer 2015) contributing to both biophysical and aesthetic form.

Physical activity–bodily movement produced by skeletal muscles that uses energy; positively correlated with physical fitness as movement increases through intensity, duration, and / or frequency (Caspersen et al. 1985).

Public health–comprehensive plans made and measures taken to ensure conditions in which people can be healthy. Focus is on preventive aspects of health at a population level as opposed to an individual level, and the promotion of health at a community scale (Turnock 2009).

Public open space–outdoor areas that are owned by government entities and accessible to citizens and visitors alike. Includes, but is not limited to: streets, sidewalks, rights of way, parks, stormwater management areas, and infrastructure (Davidson and Dolnick 2004).

Regulatory tools–land use controls addressing the type, location, and timing of development. These include, but are not limited to conventional regulations such as zoning, and subdivision ordinances, as well as innovative regulations to manage development and its impacts on the environment. These regulations include, but are not limited to: overlay zoning districts, performance zoning and transfer of development rights. (Randolph, 2004, 143).

System–a regularly interacting or independent group of items forming a unified whole; a group of related natural objects or forces; a form of (political, social, economic) organization and practice; harmonious arrangement or pattern – such as bringing order to bring system out of confusion. Accessed June 23, 2013 from: http://www.merriam-webster.com

Urban ecology–study of the interactions of organisms in both the physical and built environment, where there is a concentration of people (Forman 2014, 3).

1.7 List of Abbreviations and Acronyms

The following list includes abbreviations and acronyms for terms referenced throughout the document.

APA	American Planning Association
ASLA	American Society of Landscape Architects
BMI	Body Mass Index
BMP	Best Management Practice
CfAD	Center for Active Design
CDC	Centers for Disease Control and Prevention
CPPW	Communities Putting Prevention to Work Grant
CSO	Combined Sewer Overflow

CTG	Community Transformation Grant
CWA	Clean Water Act
ESA	Endangered Species Act
EPA	Environmental Protection Agency
LAF	Landscape Architecture Foundation
LEED	Leadership in Energy and Environmental Design
NPDES	National Pollution Discharge Elimination System
MS4	Multiple Separate Storm Sewer System
PBC	Public Benefit Conveyance
SSO	Separate Sanitary Sewer Overflow
SZEA	Standard Zoning Enabling Act
SPEA	Standard Planning Enabling Act
USACE	United States Army Corps of Engineers
USGBC	United States Green Building

Chapter Two: Literature Review

Green infrastructure has emerged as a topic of significant interest in research and practice for its potential to address sustainable urban planning and design in terms of both ecological and human health. Competition for land resources has interrupted ecological patterns and processes, fragmenting urban open space, and adversely impacting urban ecosystems (Benedict and McMahon 2006; 2002). A lack of connectivity and access to green space has been attributed to chronic (noncommunicable) health conditions caused in part by physical inactivity (Sallis et al. 2006). The previous chapter introduced my study: exploring the potential of green infrastructure as an organizing framework for urban ecological infrastructure from a planning and urban design perspective through a case study of four cities known for 'green solutions.' Analysis of the opportunities and challenges for landscapes to incorporate infrastructure for physical activity at both the municipal and project level seeks to identify the successes and lessons learned in the process.

This chapter contains a discussion of literature in two topical areas: green infrastructure as a viable component of a healthy community and physical activity from the perspective of planning, public health, and urban design. It is noted that this review is by no means representative of the breadth of literature research in these topical areas. The intent is to present relevant literature to the research question: how can green infrastructure serve as a bridge between planning and public health to realize infrastructure that provides for human physical activity at the municipal scale? In the following sections, I present a discussion of the varying definitions and concepts of green infrastructure for both research and practice interests, followed by salient examples of green infrastructure through history. Next, I summarize current lines of thought in green infrastructure planning and implementation at multiple scales, including governance of green infrastructure and potential connections to public health. A discussion of physical activity literature follows, including: definition of terms and types of study being conducted; relationship of physical activity to public health; scales of governance and guidance for physical activity; and the relationship to urban form, planning, and design. Finally, I synthesize the integration of public health, planning, and community design-identifying gaps in literature toward the healthy community design.

2.1 Green Infrastructure

The term green infrastructure came to the forefront in 1999 in the United States when the President's Council on Sustainable Development identified it as one of five key strategy areas for sustainable community development in the United States (Williamson 2003). The recommendations of the council were based on three goals for sustainability: economic prosperity, environmental protection, and social equity. The Clinton Administration report emphasized development of place-based strategies, acknowledging the unique qualities of different places as "essential to building more healthful, enduring and livable communities."[4] Green infrastructure was distinguished from traditional conservation efforts in its "pace, shape, and location of development in relationship to natural resources and amenities."[5] In this view, green infrastructure strategies actively seek to understand and value the ecological, social, and economic functions provided by natural systems to inform efficient and sustainable land use as

[4] President's Report of Sustainability, http://clinton2.nara.gov/PCSD/Publications/tsa.pdf.
[5] President's Report of Sustainability, http://clinton2.nara.gov/PCSD/Publications/tsa.pdf.

well as ecosystem protection. As the concept has evolved, it has been interpreted in multiple ways with varying definitions.

2.1.1 Defining Green Infrastructure

Infrastructure constitutes a complex framework of facilities to support and sustain human life. In the context of the city, gray infrastructure is typically associated with "engineered" aspects of the built environment composed of transportation (roads, rails, sidewalks, paved trails, and transit lines), utilities (water, sewer, and gas) lines, communication service, coupled with the social infrastructure of public buildings/institutions.[6] With the exception of public buildings, these linear infrastructure corridors operate at multiple scales, forming large, contiguous networks (Aquino et al. 2011, 7). In Europe, Sandström (2002) introduced the term green infrastructure in his evaluation of urban green space planning in Sweden. Concerned over the negative impacts to biodiversity caused by urbanization, he emphasized the multiple uses of green space: aesthetic; functional; ecological; technical; symbolic, and speculative. Adopting the phrase "green infrastructure" demonstrated a transition from green space as an amenity to a necessity, placing it equal in importance to gray infrastructure (Wright 2011). Transcending a perception of aesthetics, conservation, and recreation, urban green space offers both aggregative and performative qualities.

Multiple definitions appear in green infrastructure literature. For the purposes of this discussion, the differences among definitions and interpretations can be generally categorized into four areas: scale; national and local planning cultures and needs;

[6] http://www.americanrivers.org/

Table 2.1 Representative Definitions of Green Infrastructure (after Wright 2011)

Definition	Source	Focus
"Green infrastructure is an emerging planning and design concept that is principally structured by a hybrid hydrological/drainage *network*, complementing and *linking* relict green areas with built infrastructure that provides ecological functions."	(Ahern 2007, 267)	Green infrastructure theory
"Our nation's natural life support system-an *interconnected* network of waterways, wetlands, woodlands, wildlife habitats, and other natural areas; greenways, parks and other conservation lands; working farms, ranches and forests; and wilderness and other spaces that support native species, maintain natural ecological processes, sustain air and water resources, and contribute the health and quality of life for America's communities and people."	(Benedict and McMahon 2002, 12)	Linking theory and policy: Balancing conservation and working landscapes
"Green infrastructure is taken…to encompass connected *networks* of *multifunctional*, predominantly unbuilt, space that supports both ecological and social activities and processes."	(Kambites and Owen 2006, 484)	Linking theory and policy
"Green infrastructure uses vegetation, soils and natural processes to manage water and create healthier urban environments." Definition is subdivided into levels of applications for community (patchwork of areas for habitat and flood protection, improved air and water quality), and neighborhood (stormwater management systems that mimic nature by treating and storing water).	Environmental Protection Agency[7]	Policy and Implementation: stormwater management, flood mitigation
Strategically planned and managed *networks* of natural lands, working landscapes, and other open spaces that conserve ecosystem values and functions and provide associated benefits to human populations.	Green Infrastructure Community of Practice[8]	Policy and implementation: conservation
"Green infrastructure can be considered a conceptual framework for understanding the "valuable services nature provides the human environment." At the national or regional level, *interconnected* networks of park systems and wildlife corridors preserve ecological function, manage water, provide wildlife habitat, and create a balance between built and natural environments. At the urban level, parks and urban forestry are central to reducing energy usage costs and creating clean, temperate air."	American Society of Landscape Architects[9]	Design and implementation
"Green infrastructure (GI) is the *network* of green spaces that protects natural ecosystems and provides associated benefits, such as clean water and air, to communities. For these reasons, its protection should be a high priority for local governments."	American Planning Association[10]	Policy

7 http://water.epa.gov/

8 The Conservation Fund organized the Community of Practice to promote national conservation priorities. It is composed on over fifty professional organizations, corporations, consulting firms, non-profit groups, and government agencies.

9 http://www.asla.org/greeninfrastructure

10 https://www.planning.org/pas/quicknotes/pdf/QN27.pdf

disciplinary perspectives and types of research questions posed; and professional practice interests. Focus areas align with theory, policy, design, and implementation. The definitions illustrate a lack of consistency in wording, and an emphasis on different environmental and social focuses based on differing interests and knowledge cultures of the sources listed. Descriptive terms most cited include the concepts of scale, connectivity, multi-functionality, and network.

Benedict and McMahon (2002) presented a balanced view of green infrastructure, considering the importance of both working (anthropocentric) and conservation (ecocentric) landscapes (Kambites and Owen 2006). Although this definition has been generally adopted in green infrastructure literature (Young et al. 2014; Walmsley 2006; Kambites and Owen 2006; Mell 2009), it is acknowledged "the term means different things to different people" (Lafortezza et al. 2013). An attempt to synthesize the concepts into a single definition is unlikely, and I argue unnecessary, given differing national and local planning cultures and needs (Pauleit et al. 2011). Furthermore, the lack of a dominant theory for green infrastructure planning can be attributed to foundation in both social and natural sciences (Roe and Mell 2013, 652). Divergent perspectives among disciplines in research approaches, as well as differing professional practice interests affect the focus and direction to operationalize the term.

For the purposes of this study, green infrastructure is defined as interconnected network of green spaces across spatial scales, composed of both human-made (engineered) and natural features (Benedict and McMahon 2006; Williamson 2003; Dunn 2010). It provides the foundation for sustainable land use and development by supplying the natural resources to support human systems.

Green infrastructure is both object and process. It is an interconnected network of green spaces that is composed of both human-made and natural features, "public and private conservation land, working lands with conservation values, and other protected open spaces" (Benedict and McMahon 2006). As a process, it promotes a strategic approach to land management and conservation at multiple scales: local, regional, state, and national (Benedict and McMahon 2006).

As a system, green infrastructure can be described as a hierarchy of hubs, links, and sites across spatial scales, connecting a variety of landscape features and ecosystems (Benedict and McMahon 2006). The hubs serve as an anchor for the network, providing space for different types of natural processes, as well as an origin or destination for wildlife (Williamson 2003). Links are corridors that provide connections between the hubs, connecting existing parks and preserves. For instance, river, stream, and arroyo corridors provide opportunities for recreation while maintaining a corridor for migration of wildlife. Sites are typically smaller in size than hubs, and may not have a direct connection to a larger overall system (Figure 2.1). They function in support of the system, and create opportunities for recreation and land conservation (Benedict and McMahon 2006).

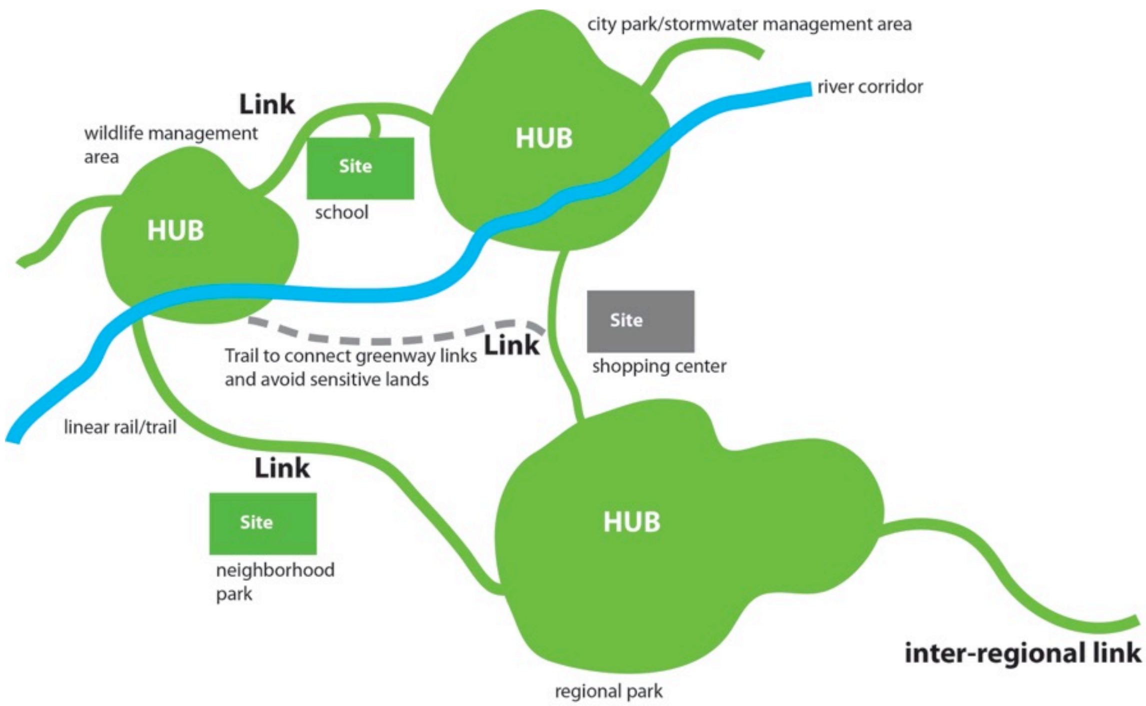

Figure 2.1 Open Spaces: Components of a Green Infrastructure Network (after Erickson 2006)

2.1.2 Green Infrastructure Concepts

The integrative nature of green infrastructure invites multiple interpretations of its concepts. An appeal to a wide range of academic disciplines and practitioners provides a people based approach to landscape planning, emerging from foundations in landscape ecology (Roe and Mell 2013, 670). Concepts have been associated with sustainability in terms of the social, ecological, and economic benefits of urban green space (Tzoulas et al. 2007; Pauleit et al. 2011). Urban form and aesthetics of green infrastructure contribute to the image of a city and its quality of life (Pauleit et al. 2011; Lynch 1981). Green space has been linked to human health for its positive influence toward psychosocial and physical well-being (Tzoulas et al. 2007; Young et al. 2014; Austin 2014). As interest increases among disciplines to describe characteristics of green infrastructure planning for research and practice, several studies have developed sets of principles.

In review of the literature, precepts developed to characterize the tenants of green infrastructure planning (Benedict and McMahon 2006; Ahern 2007; Kambites and Owen 2006; Pauleit et al. 2011; Hansen and Pauleit 2014; Roe and Mell 2013) are numerous and diverse. Shared principles were identified and are summarized in Table 2.2.

One of the primary benefits of green infrastructure as a concept is its application to a broad range of ecological, social, and economic benefits (Mell 2013). Its potential to combine ecological and social perspectives (Hansen and Pauleit 2014; Mell 2009) has been widely recognized. This diversity, however, appears to be the basis for its discourse. Several frameworks have been developed, fragmenting its agency as a meaningful component of urban ecological planning. Ahern (2007; 2010) identified abiotic, biotic, and cultural characteristics of green infrastructure, citing connectivity as the landscape characteristic linking structure and function. In his efforts to connect landscape ecological and social aspects of urban green space, Tzoulas (2007) proposed a model to promote human health. The role of green infrastructure as nature in cities to promote human health and well-being relates ecological and social infrastructure (McPhearson et al. 2014). As part of a complex urban system, green infrastructure has also been characterized as part of a 'Gray-Green Continuum' (Davies et al. 2006). In this model, 'elements considered gray,' which contribute to the holistic functioning of green infrastructure, are integrated into green infrastructure network, rather than as a subset of gray infrastructure.

Table 2.2 Green Infrastructure Planning Principles

Principle	Description	Source(s)
Comprehensive Approach	Targets urban, urban fringe and countryside as a holistic planning environment composed of multiple 'green' components. Consideration given to geography, political boundaries, and functionality.	(Roe and Mell 2013; Benedict and McMahon 2006; Kambites and Owen 2006)
Integration	Considers urban green space as a type of infrastructure to be coordinated with other urban infrastructures (such as transportation, water management) as they relate both functionally and physically.	(Hansen and Pauleit 2014; Pauleit et al. 2011)
Multifunctionality	Seeks to combine ecological, social, and economic functions of green spaces where compatible. Interest directed toward benefitting human population in terms of both aesthetics and functionality, emphasizing the potential for interaction.	(Roe and Mell 2013; Hansen and Pauleit 2014)
Connectivity/Linkage	Includes physical and functional connections between green spaces from different scales and from different perspectives; i.e. recreation, biodiversity, urban climate, stormwater management.	(Pauleit et al. 2011; Hansen and Pauleit 2014)
Multi-scalar Approach	Uses concept of landscape scale with reference to natural and cultural processes for planning. Temporal scale (time) is an integral component of scalar considerations. Initiatives vary from individual parcels, to community, region and state. Intent is functionality at multiple scales in concert.	(Roe and Mell 2013; Hansen and Pauleit 2014)
Transdisciplinary Approach	Builds on expertise from different disciplines to create new knowledge: landscape ecology; landscape architecture; community and regional planning. Developed collaboratively with various local authorities and participants.	(Hansen and Pauleit 2014; Ahern 2007)

While several models exist, no cohesive model prevails to guide city planning. Scant research has been found to operationalize the principles of the concept.

Green infrastructure planning suffers from a lack of analytical study to demonstrate how core principles are operationalized, and how theoretical concepts are applied in practice. The models listed above advocate the principles of green infrastructure, but do not address advancement of the field's theoretical foundations (Hansen and Pauleit 2014). Few studies examine green infrastructure planning in practice (Sandström 2002; Lafortezza et al. 2013; Young and McPherson 2013). Best practice examples address design and implementation issues, yet do not often relate practice to theory. Therefore, approaches to better understand and further develop the principles of multi-functionality, connectivity, and transdisciplinary approaches are missing (Hansen and Pauleit 2014).

Building from disciplinary interests in the understanding and use of core green infrastructure concepts, the integrated balance of competing conservation and development interests posited by Benedict and McMahon, is further tested. A division of working landscapes for resource consumption versus conservation landscapes dedicated to resource protection permeates both academia and practice. Nomenclature and practice have been evident in the evolution of this field of study.

2.1.3 Background–Salient Examples Through History

Although green infrastructure gained popularity in the early twenty-first century, the concept is not a new one. In the late nineteenth century, recognizing that the artificial

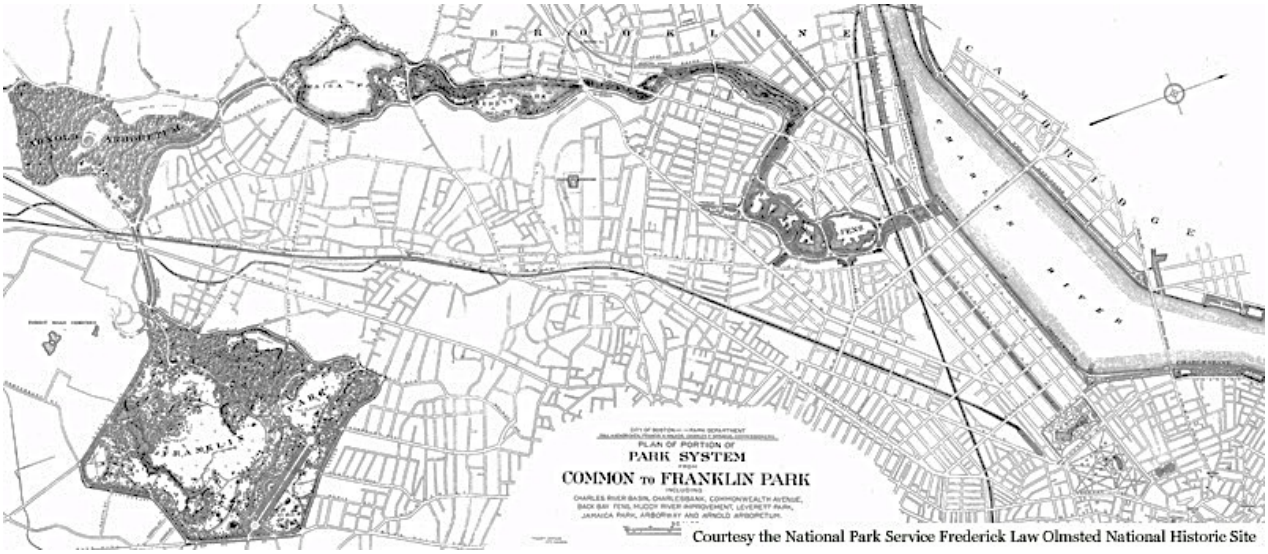

Figure 2.2 Boston's Emerald Necklace: Franklin Park to Boston Commons (source: National Park System, Frederick Law Olmsted Historic Site)

context of the urban environment was detrimental to both physical and mental health, landscape architect Frederick Law Olmsted, Sr. designed urban projects incorporating the principles of green infrastructure. These included such projects as Boston's Fens and Riverway, and Central Park in New York (Little 1990; Rybczynski 1999). Built on a site of tidal flats that was impacted by sewage and industrial effluent, the Fens and Riverway project formed a multi-functional landscape system in its construction of a wetland, interceptor sewer, parkway, and streetcar line (Spirn 1995; Spirn 2002). This system accommodated the movement of people, flow of water, flood prevention, and waste removal (Spirn 2002, 38).

Olmsted's project was celebrated for its organizing framework, connecting cultural, and ecological components of the community. Critics of the project argued that its aesthetic quality downplayed the significance of the working landscape and its influence on adjacent land use patterns. Olmsted's work extended beyond individual park sites to a citywide system of parks and parkways in Boston, Buffalo (Eisenman 2013, 297), Brooklyn (MacDonald 2002), and Louisville (Meringolo 2008). Tree-lined boulevards between the parks provide bicycle and pedestrian access, encouraging freedom of movement and spaces for gathering (Meringolo 2008). In Louisville, "he advocated that the parks be managed as a singular system" (Meringolo, 107) where the parkways linked the 'city's three major parks–Cherokee, Iroquois, and Shawnee.' Olmsted's body of work serves as a precedent to the green infrastructure model of hubs, links, and sites.

The study of land use development patterns has contributed in building the foundation for green infrastructure. Geologist John Wesley Powell studied possible configuration of human settlement patterns across the American west. He found that settlements occurred adjacent to water were most efficient in the arid region, leading him to recommend that watersheds be utilized as planning units (Benedict et al. 2003). Ian McHarg's work, beginning in the 1960s, influenced design and land development in his ecologically based land suitability analyses (Ndubisi 1997). His techniques matched development feasibility with physical features and land use characteristics in an overlay system to inform designs compatible with natural systems.

These principles were clearly portrayed as multi-functional landscape systems in mixed land use projects. One such project is The Woodlands north of Houston, Texas, considered one of the most influential planning projects of the 1970s (Wenk 2002, 178). Another contributor to this ecologically based concept was landscape architect Philip Lewis, whose work in Illinois and Wisconsin during the 1960s–1980s addressed green infrastructure planning at the landscape scale, producing regional land use plans based on ecological principles (Wenk 2002; Benedict et al. 2003; Thayer 2003). Lewis employed a network approach to green space management in his research of ecological 'greenway' corridors. In this way, green space was operationalized to "achieve diverse aims and multiple functions" (Roe and Mell 2013), and the greenway movement made a significant contribution in the advancement of green infrastructure (Benedict et al. 2003; Roe and Mell 2013).

An example of Lewis' work includes his regional landscape inventory in Wisconsin, focusing on the evolution of regional design (Lewis 1996; Thayer 2003). Lewis introduced the hypothesis of co-occurrence of greenway resources, positing that cultural landscape resources are spatially concentrated in environmental corridors (Ahern 2004, 37). His claim offered three strategic advantages for greenways: spatial efficiencies to protect resources; political support contributing to mutual benefits that diverse interests can realize from greenway protection, such as recreation, biodiversity, and water quality; and the benefits accrued from connectivity of resources through greenway corridors from ecological, cultural, and physical perspectives (Ahern 37). The importance of Lewis' co-occurrence lies in its ability to show multiple communities that "respective interests are often spatially coincident" (Ahern 37). His work shaped the approach to landscape scale greenway strategies in other areas of the country to co-locate cultural and natural resources to form multi-functional landscapes.

Landscape scale strategies were later incorporated in Florida during the 1990s, when the Florida Greenways Commission developed a concept for a statewide greenways system. The purpose of the plan was two-fold: to create a connected system of native landscapes and ecosystems that would support biodiversity, clear air, water, and other natural resources; and to provide scenic and recreation resources for both Florida residents and visitors (The Conservation Fund 2004). This study advanced the importance of ecosystem services as a component of a green infrastructure network leading to the establishment of the Florida Greenways and Trails Council (FGTC) by the Florida legislature in 1999 (Florida Statute 260.0142). The FGTC currently advises the Florida Department of Environmental Protection (FDEP) and its Office of Greenways and Trails on greenway and trail related issues, promotes intergovernmental coordination, and recommends priorities for critical linkages and funding for both the development and management of the system.[11] Composed of existing, planned, and conceptual trails and ecological greenways, FDEP's Greenways and Trail System Plan serves as a green infrastructure plan for Florida and connects the plans and planning activities of state and local agencies, non-profits, and municipalities. The tangible and intangible benefits of the green infrastructure system are expressed through the ecosystems services it provides.

2.1.4 Green Infrastructure and Ecosystem Services

An important contribution in the evolution of green infrastructure lies in the recognition of benefits that human populations gain from ecosystems. The United Nations published the Millennium Ecosystem Assessment in 2005, categorizing ecosystem services into four groups: provisioning services that combine with built, human, and social capital to produce benefits such as food, water, timber, or other material or energy benefits; regulating services such as flood control, water purification, pest and climate control; cultural services that combine capital to provide recreation, aesthetic, or other cultural benefits; and supporting services that indirectly affect human well-being such as habitat for animals, soil formation, and carbon fixation (Costanza et al. 2011; Costanza et al. 1997).

Environmental settings that produce a broad array of ecosystem services are referred to as multi-functional landscapes. They provide "multiple environmental, social, and economic functions in a given area of land, taking into account the interests of the

[11] https://www.dep.state.fl.us/gwt/FGTS_Plan/PDF/FGTS_Plan_2013-17_publication.pdf

landowners and users" (Lovell and Johnston 2009, 214). This concept of multi-functionality contrasts with that of sustainability in its goal to consider ecological function, production, and cultural functions on the same site (Lovell and Johnson 2009, 214), and its use of an ecosystem framework for planning to understand the landscape at multiple scales (Spirn 1985). The ecosystem services and societal needs in multi-functional landscapes operationalize both the concept and process for green infrastructure.

The benefits from ecosystem services were depicted in the Millennium Ecosystem Assessment (2005) in relationship to the determinants of human health and well-being. Figure 2.3 highlights the association of changes in these services that may impact health.

Regulating services from natural processes, and cultural services in terms of nonmaterial benefits illustrate the relationship between ecosystem services and determinants of health and wellness as it relates to my study of green infrastructure and physical activity. Costanza's (2008) description by spatial classification further conveys the concept of multi-functionality. Dividing services into proximal and non-proximal services, two relate specifically to the concept of multi-functionality and human interaction: directional flow from point of production to point of use, as in water regulation and flood protection; and user movement in terms of flows of people to unique natural features.

Costanza's work (2011; 2008; 1997) concentrated on valuation of ecosystem services, yet he recognized the complexity and ambiguity of classifying ecosystem goods and services for multiple purposes and from multiple perspectives. He observed these intricacies through stormwater valuation of wetlands, pointing out the challenge of communicating the complex relationships among patterns of landscape and precipitation,

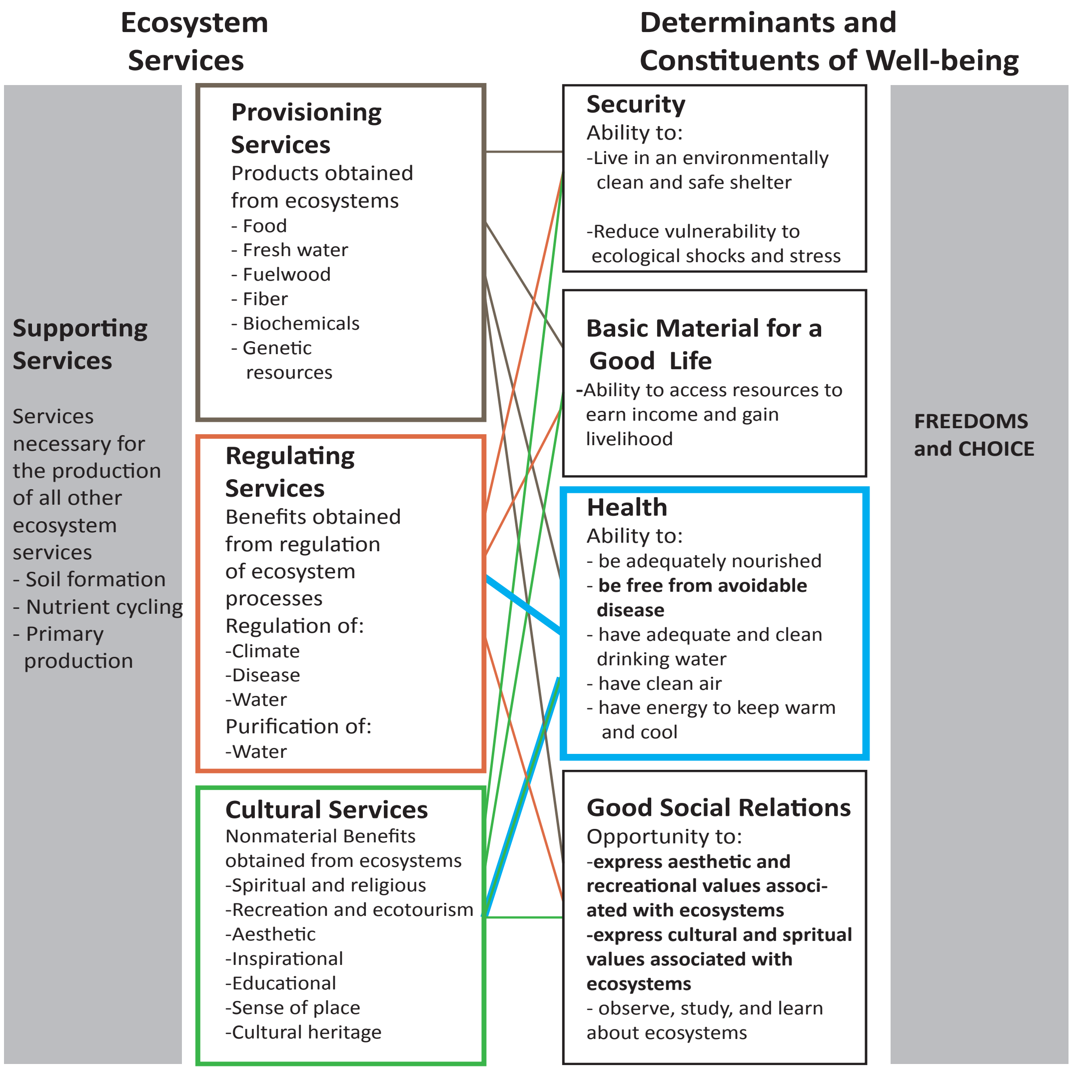

Figure 2.3 Ecosystem Services and Human Well-Being (after Millennium Ecosystem Assessment Framework, 2003)

wetlands, and flood attenuation (2008, 350). He questioned the ability to increase understanding to the general population while scientists remain challenged by the assignment. These disciplinary and communicative encounters further confound urban ecology research and implementation of urban ecological infrastructure.

Cities remain dependent upon ecosystems to support long-term conditions for human life (Odum, E. 1989) beyond formal jurisdictional limits, yet benefit from such services within the city. Urban natural areas often suffer from fragmentation and disturbance, making the city a distinct form of environment: “We often think of human development as destroying ecosystems, but it’s more accurate to say it creates drastically different ones” (Flint 2014). There has been a shift in recent years in urban ecological study from ‘ecology in cities’ to ‘ecology of cities’ (Grimm et al. 2000). Ecosystem services provide the framework that connects ecological and social infrastructures in the city, providing benefits to both humans and ecosystems (McPhearson et al. 2014, 502). In this context it becomes essential to distill ecosystem services to a city scale.

Research pertaining to urban ecosystems has advanced the understanding of goods and services in several areas: biophysical (Demuzere et al. 2014; Felson et al. 2013), sociocultural (Adams et al. 2014) and economic (Costanza et al. 2008). In their study of ecosystem services in Stockholm, Sweden, Bolund and Hunhammar (1999) identified six of seventeen ecosystem services (Costanza et al. 1997) applicable to the city scale: air filtration; micro-climate regulation; noise reduction; stormwater drainage; sewage treatment; and recreational/cultural values. Acknowledging that some services are generated simultaneously, all components identified contributed to climate regulation and the provision of cultural/recreational infrastructure.

Subsequent studies have focused on single components of ecosystem services relevant to green infrastructure, rather than advancing the study of green infrastructure as an urban system (Gomez-Baggethun and Barton 2013). Similar to green infrastructure planning research, most of the literature provides theoretical models to be applied at a range of scales, with empirical evidence largely reliant on site scale case studies. Better examples are needed to show the connections or lack thereof between spatial scales, policy and implementation. Research at the municipal scale includes climate and heat island effects (Stone 2010, Vargo et al. 2013), municipal tree planting programs (Young and McPherson 2013), stormwater management (Bunster-Ossa 2013, Wenk 2002), parks and open space preservation (Harnik 2010; Griffith 2011), and resilience planning and management (McPhearson et al. 2014). Understanding the range of spatial scales of green infrastructure and ecosystem services is needed to situate appropriateness of elements and types of study to advance urban ecological infrastructure.

2.1.5 Spatial Levels of Green Infrastructure

The ecosystem services and benefits provided by green infrastructure are realized at multiple scales. Placing this in a municipal framework becomes complicated as spatial organization and functions at ecological scales do not necessarily match those of political jurisdictions (Berke 2007, 61). The Millennium Ecosystem Assessment (2005) outlined the potential mismatch of levels of occurring ecological events and those at which decisions are made. Figure 2.4 offers a comparison of ecological and institutional levels of organization.

Most of the interaction between people and ecosystem services takes place at the local scale (MA Framework 2003), involving individual elements of green infrastructure (Hansen and Pauleit 2014), in both functional and proximate elements and sites. Elements include stormwater management conveyances and urban street trees. Individual sites may consist of parks and green infrastructure elements that contribute to human wellness benefits, which may or may not be nested in an ecological network hierarchy. This puts an emphasis on direct and locally generated services, influenced by ways in which green infrastructure is governed.

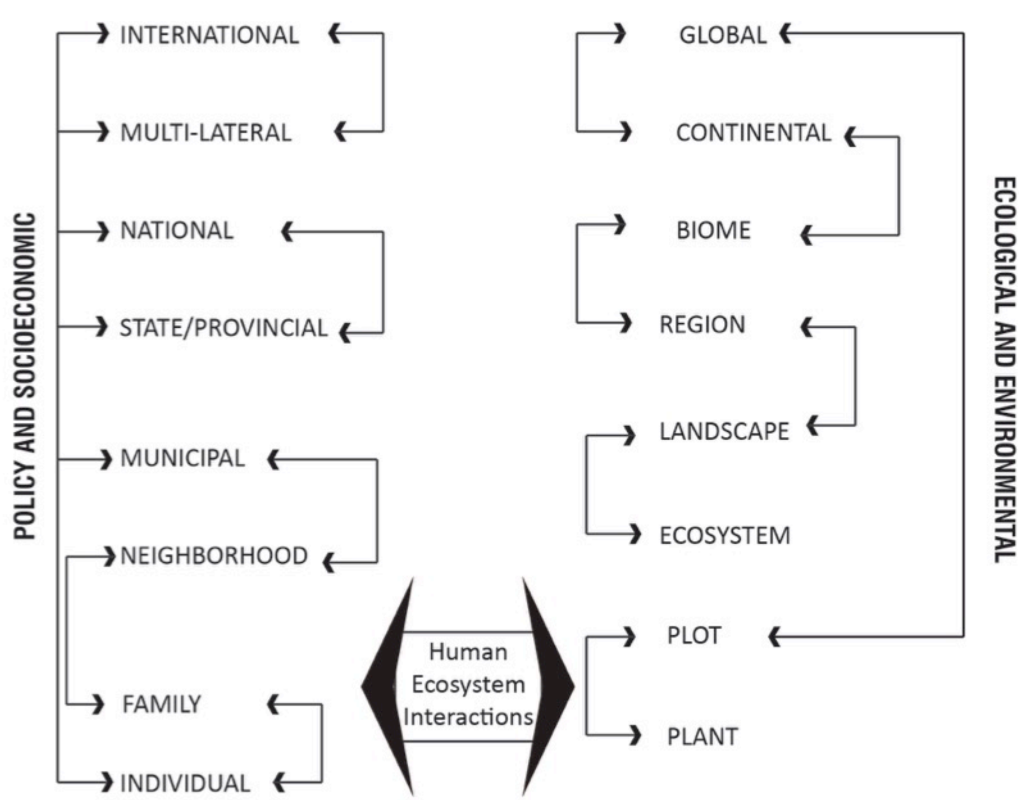

Figure 2.4 Institutional and Ecological Scales (after Millennium Ecosystem Assessment Framework, 2003)

2.1.6 Governing Green Infrastructure

Although green infrastructure is supported by a number of government agencies at the federal level[12] for a wide range of development and environmental issues, the Clean Water Act (CWA) of 1972 greatly influenced local land use decisions by prompting implementation of green solutions for stormwater management. Prior to CWA and its resulting regulatory requirements, stormwater runoff was considered as disposable waste (Forman 2002, 86). Federal mandates provided the motivation to reconceptulize stormwater as "a resource to be managed, treated, and distributed for re-use where feasible" (Forman 86). Administered by the Environmental Protection Agency (EPA), requirements for green infrastructure processes and permits have had a significant impact on local governance.

Through amendments to CWA, legislation mandated that municipalities and certain industrial sites submit to regulations to control stormwater runoff. Two areas of regulatory compliance currently guide land use decisions at the local scale. One resides in the enforcement actions for combined and separate sanitary sewer overflows (CSO and SSO), where mitigative supplemental projects are pursued in lieu of monetary penalties (Thurston et al. 2008). The second is the National Discharge Pollution Elimination System (NPDES) program. Initiated in two phases for cities to secure permits for pollutant discharges from stormwater runoff, Phase I addressed cities with populations of 100,000 or more, while Phase II was intended for municipal separate stormwater systems (MS4) serving less than 100,000 people (Preston, 2008; Thurston et al. 2008). The role of local governments was expanded significantly by the requirements of Municipal Separate Storm Sewer System (MS4) permits through an "iterative process for determining best management practices" (Breckenridge 2014, 23). Typically

[12] www.narc.org

negotiated and included in permit conditions of approval, best management practices (BMPs) prescribe methods and performance measures for project implementation and maintenance. Strategies for best management practices include, but are not limited to: ecoroofs, bioswales, vegetated curb extensions to collect stormwater runoff, planting of street trees, and removal of exotic or invasive vegetation. Both state and local regulatory processes have integrated EPA's environmental standards for best management practices (Bunster-Ossa 2013, 301). A list of recommended BMPs is found on the EPA website,[13] as well as other agencies' recommendations at the state and regional levels.[14]

Resistance to innovative BMP solutions was evident during the early years of NPDES compliance. In Congressional hearings before the House Committee on Science and Technology regarding green transportation infrastructure (2007), contradictions were identified in the regulatory process. The same federal, state, and local agencies actively promoting green infrastructure were cited for presenting obstacles in the permitting approval of projects. One such example is the Clean River Plan for the Willamette River, prepared by the city of Portland, Oregon in 2002. City planners proposed use of bioswales for treatment of stormwater runoff as part of the management plan. As regulating authority was not familiar with effectiveness of bioswales to treat runoff, the proposal failed to gain support from the Oregon Department of Environmental Quality and EPA. At that time, gray solutions were favored by both agencies. Participants called for alignment of regulatory policies with green initiatives. Evidence of advances made in this area is significantly lacking.

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[13] www.epa.gov
[14]www.marc.org

Project scale research indicates the effectiveness of green infrastructure utilizing best management practices for low impact development (Ando and Netusil 2013) for stormwater treatment (Flynn and Traver 2013), flood control (Liu et al. 2014), and climate mitigation (Stone et al. 2010; Demuzere et al. 2014). Other aspects have been incorporated into stormwater projects in terms of energy conservation, land use, recreation, energy conservation, and economic development (Bunster-Osso 2013, 301). Although advances have been made at the project scale, I argue that the focus on stormwater management issues may have displaced multi-functional aspects of green infrastructure ancillary to meeting EPA stormwater management requirements.

In terms of municipal plans, little evidence has been found incorporating ecological science for implementation practices for watersheds, wildlife habitats, and natural hazards (Berke 2007). In cities such as Chicago, lauded for its focus on green infrastructure solutions, there is a lack of a central governmental approach for its green infrastructure initiatives, with information dispersed among several municipal departments (Economides 2014, 15). Public environmental awareness for green solutions has grown in recent years (Bunster-Osso 2013), yet much needs to be done to work toward conceptualizing the city as a green infrastructure system.

2.1.7 Urban Form and Design

The ecological framework of the city shapes urban form, influencing both planning and design. Landscape architects and planners have incorporated ecological information into the design process (Spirn 1985; McHarg 1969), yet few large scale urban projects have been developed based on green design principles in recent years (Loukaitou-Sideris 2012). A notable exception is New York's Freshkills Park, designed by James Corner Field Operations, which integrated ecology in the reclamation of a 2,200-acre (890 hectares) landfill (Steiner 2014, 308) to host a variety of uses to facilitate habitat for both flora and fauna, as well as multiple spaces for physical activity. The High Line, also in New York City and designed by James Corner Field Operations, repurposed a 1.45-mile (2.3 kilometers) abandoned rail corridor to create an urban linear park (Steiner 2011a, 333). A succession of created plant communities reinforces a theme of 'wildness', although few signs of wildlife exist within the High Line (Foster 2010, 330). Examples such as these illustrate the potential for innovation in urban form as it relates to urban ecological infrastructure, yet many other large-scale urban design proposals remain unbuilt. Furthermore, scant research links such projects toward a municipal system of multi-purpose performative infrastructure.

2.1.8 Planning and Design Perspectives

The roles of physical planning and design practice relative to green infrastructure rely on both disciplinary identity and dimensions of scale. To accomplish the goals of green infrastructure to promote health, planning and design should function in what Ewing (2011) refers to as "distinct but complementary disciplines." An emphasis on translating policy goals into physical planning at a broad scale benefits the knowledge to action approach required to realize green infrastructure by establishing a framework to enable innovative design solutions.

Rouse and Bunster–Osso (2013) describe green infrastructure planning as regional and municipal efforts linked with design to promote positive outcomes. Planning goals are conceptualized in: regional growth and vision plans; municipal comprehensive plans and functional master plans, as well as development codes, ordinances, and capital improvement programs; district master plans that detail green infrastructure networks; and site developments that enact standards and guidelines to optimize green infrastructure benefits. In this model, intersection of planning and design connects planning goals to assist with place making during the design of projects at different scales. Project typologies range from: resource base parks and greenways at a regional scale; municipal level parks, waterfront projects, and streetscapes; district parks and streetscapes; and site scale courtyards, green roofs, rain gardens, and bioswales.

2.1.9 Green Infrastructure and Health

In practice, cities are adopting programs to address stormwater, water quality, and climate conditions. Little documentation exists, however, to assess the impacts and benefits of such practices. Additionally, research gaps exist relating ecological health and physical activity (Coutts and Taylor 2011). Green infrastructure at the municipal level consists of a strategically planned and managed network of open space of both working and natural lands that conserves ecosystems and provides associated benefits to human populations. Rather than single purpose infrastructures, green infrastructure that supports physical activity combines public infrastructure to support physical activity such as parks, sidewalks, trails, bikeways, and street trees with one or more of the following: water management areas, wildlife habitat areas, urban agriculture, utility rights of way, riparian corridors, and vacant lands. My research combines these perspectives to represent common interests to include infrastructure for physical activity as a component of both working and natural landscapes.

2.2 Physical Activity

The promotion of physical activity is a multi-level field of study that draws from a broad and diverse range of expertise. Originally composed of researchers in behavioral science, kinesiology, and public health (Sallis et al. 2006), the field now encompasses several disciplines, including but not limited to: planners, public health professionals, epidemiologists, parks and recreation specialists, landscape architects, urban designers, and architects. This emerging area of study gained prominence on the national public health agenda with the publication of the Surgeon General's report of 1996, which provided guidelines for moderate levels of physical activity for all Americans. The intent of the guidelines was to reduce obesity and the pandemic of chronic illnesses associated with being overweight.

With multiple disciplines gaining interest in research over the last two decades, the growing body of literature offers perspectives from differing vantage points on the environmental influences that affect physical activity levels. Empirical evidence suggests a relationship between the built environment and physical activity (Sallis et al. 2006). A wide range of environmental features has been identified to improve characteristics contributing to places conducive to physical activity in the built environment.

2.2.1 Definitions and Concepts

Physical activity refers to any bodily movement that results in the burning of calories (Casperson et al. 1985), and criteria for goal attainment fall within two categories: moderate intensity, such as walking or gardening, or vigorous–as in running or cycling through a spinning class. The Centers for Disease Control and Prevention (CDC) outlined two types of physical activity recommended on a weekly basis to improve health in its *2008 Physical Activity Guidelines for Americans*.[15] Muscle strengthening and aerobic activity recommendations offer a variety of ways in which to meet goals for improved health. Table 2.3 illustrates representative examples for adult aerobic physical activity.

Table 2.3 Recommendations for Adult Physical Activity (after CDC 2008)

Intensity	Duration	Frequency	Examples
Moderate (60-74% of maximum heart rate)	30 minutes or more in one long bout or several 10-minute bouts	5 or more days of the week (150 minutes/week)	Brisk walk for 30 minutes 10 minutes of walking, 10 minutes of raking, 10 minutes of playing with the kids
Vigorous (75-80% of maximum heart rate)	20 minutes or more	3 or more days a week (75 minutes /week)	Jogging for 20 minutes Spinning class Swimming laps

Ecological perspectives on physical activity have been developed through models that focus on both physical and social ecology. Physical ecology is comprised of components contributing to urban form, such as open space, land use, and transportation systems (Loukaitou-Sideris 2003, 3). Social ecology is described as:

"a framework or set of theoretical principles for understanding the dynamic interrelations among various personal and environmental factors in health. Social ecology pays explicit attention to the social, institutional, and cultural contexts of people-environmental relations and draws on both large-scale preventative strategies of public health and individual level strategies of behavioral sciences and medicine" (McLaren and Hawe 2005, 12).

These combined effects are represented in the social ecological model, which evolved from an increasingly ecological orientation of the health promotion discipline in the late 1900s (Stokols 1996, 282). This model distinguishes physical activity in four

[15] http://www.cdc.gov/physicalactivity/everyone/guidelines/adults.html

domains: recreation, transportation, occupation, and household (Sallis et al. 2006, 122). The domains relate to distinct environmental variables. Influences occur in venues such as transportation systems, parks and recreation areas, neighborhoods, and building structures.

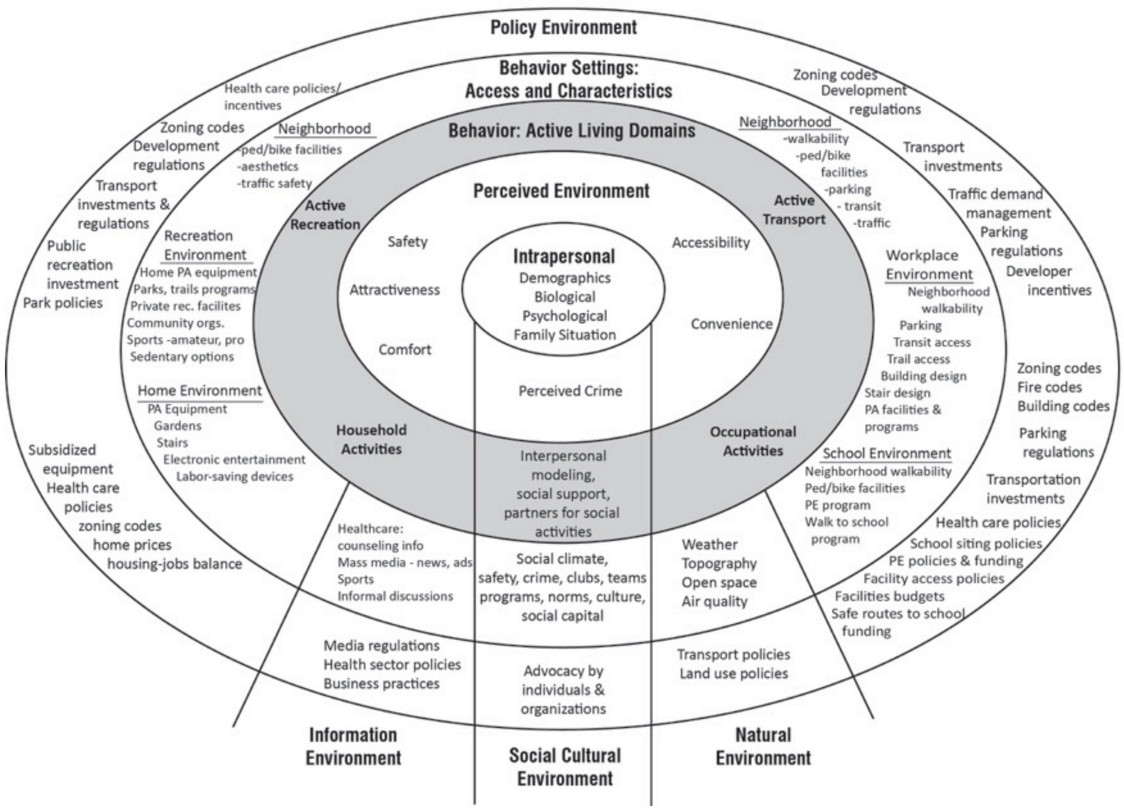

Figure 2.5 Ecological Model for Four Domains of Active Living (after Sallis et al. 2006)

The model constitutes the framework that applies environmental correlates to inform community design, social interventions, and public policy on matters regarding physical activity in the built environment. The built environment is defined as physical “settings designed, created, and maintained by human efforts” (Frumkin et al. 2011) such as buildings, public spaces, and infrastructure systems. The Robert Wood Johnson Foundation supported much of the early physical activity research in an initiative referred to as the Active Living Movement (Kaczynski and Henderson 2007, 319). The movement advocated multi-level strategies designed for policy and environmental change at the community level to promote physical activity as part of an everyday lifestyle for Americans (Bussel et al. 2009, S309). The most common forms of physical activity are bicycling and walking.

Activities such as walking and bicycling intersect two domains: transportation and recreation. Active transportation addresses the utility aspects of non-motorized modes, such as walking or cycling to go to work or to the store, with a goal of reaching a destination. Recreation generally relates to active leisure time in parks or open spaces.

Table 2.4 Comparing Characteristics of Recreation and Transportation Physical Activity

Recreation Physical Activity	Transportation Physical Activity
Being somewhere	Getting somewhere
Proximity to recreation areas and leisure activities	Proximity from origin to destination
Access to public and/or private recreation areas	Directness from origin to destination (i.e., “walkability” or “bikability”)
Infrastructure comprised of gray and green infrastructure for both organized and unstructured activity, such as sports courts, playgrounds, open play areas, and/or water dependent facilities	Infrastructure consisting of sidewalks, bike lanes, trails

Studies on recreational walking and cycling overlap with those on walking and cycling for transportation (Forsyth and Krizek 2010). Characteristics differ between the two domains; I contend, however, that shared infrastructure may contribute to an improved and interconnected network for non-motorized mobility. Furthermore, integration of the built and natural environment (where compatible) provides the opportunity to explore systematic ways to provide a cohesive web for physical activity.

Researchers in several disciplines have conducted studies on walking and bicycling in various forms of public open space, identifying access and other key determinants. Key determinants of physical activity are "modifiable factors in the physical environment that impose a direct influence on opportunity to engage in physical activity" (Gordon-Larsen et al. 2000, 1). A review of over 300 empirical studies on bicycling and walking by Forsyth and Krizek (2010) found research interests aligned with disciplinary interests: livability for those in urban design, preserving the environment by urban planning, efficiency by transportation engineers, and promotion of physical activity from public health. Findings summarized community design as having a high degree of efficacy in increasing walking, yet a low degree associated with high quality infrastructure (tree line paths). In several areas, results from different studies were contradictory in terms of policy and plan recommendations.

One of the criticisms of the research in physical activity lies in its limited operationalization of the use of multiple variables across domains in the socioecological model. Studies to date have largely focused on a single domain of physical activity: recreation for leisure time in parks or neighborhood open spaces (Kaczynski and Henderson 2008), or for transportation purposes on public streets and sidewalks (Cervero and Kockelman 1997; Krizek and Johnson 2006; Southworth 2005). Much of this work has been conducted at the neighborhood scale, and few data exist that reach across disciplines to address issues at the community level.

2.2.2 Situating Physical Activity with Public Health

In the emergent field of physical activity, research has been conducted primarily in the fields of public health and kinesiology. Public health did not, however, make a connection to health as physical activity until the mid-twentieth century. Here it is important to distinguish between 'public health' and 'health.' Public health refers to "what we as a society do collectively to assure the conditions in which people can be healthy" (IOM 1988). The World Health Organization defines health as "a dynamic state of complete physical, mental, spiritual, and social well-being and not merely the absence of disease or infirmity".[16] To situate my research aim of bridging planning, design, and public health, the following discussion provides a summary of the historical linkages between public health, planning, and design, and the emergence of physical activity as an area of research.

Historically, public health and planning were linked through the concern for urban housing and environmental health. Public health in the nineteenth century concentrated on sanitation reform in cities, with problems occurring in several environmental categories: air, water, garbage, sewage, commercial activity, and housing (Frumkin et al. 2004, 46). Rapid population growth combined with a number of other factors such as inadequate housing, substandard sewage disposal, and degradation in air quality led to unsafe and unsanitary living conditions for many, which influenced the way urban centers grew and developed.

Reforms led to the establishment of public health entities in the United States (Frank et al. 2003, 13). Sanitation reform was not limited to the health professions in the late nineteenth century. Frederick Law Olmsted became involved in the movement when he was appointed the secretary of the U.S. Sanitation Commission in 1861 (Rybczynski

[16] http://www.who.int/about/definition/en/print.html

1999). He confronted urban design characteristics that caused overcrowding and inadequate sanitation during and after the Civil War. Olmsted was greatly influenced by his experience in public health, as demonstrated in his design approach to a variety of projects and project types. His work throughout the United States successfully integrated the complexities of a multi-functional landscape.

Public health proceeded to shape cities in the twentieth century with establishment of zoning laws to separate incompatible land uses for health, safety, and welfare of citizens. The effect of zoning on land use patterns often dictated types of land uses, as well as the location and types of public facilities within a community. Building codes further delineated requirements for design and construction relative to massing, bulk, structural integrity, and form of built structures (Frumkin et al. 2004; Davidson and Dolnick 2004). Public health continued to be concerned with disease control and environmental hazards throughout the twentieth century, and subsequently since 1999, public health in the United States has been "preparing for and responding to community health threats" (Turnock 2009, 8). Physical inactivity has been identified as one of these health threats.

The connection between public health and physical activity occurred in the 1950s, when the President's Council on Physical Fitness was formed, encouraging America's youth to participate in team sports (Pate 1989, 290). Although the program was expanded through the years, it was not until the landmark Surgeon General's 1996 report that physical activity was brought to the forefront of the public health agenda. As terms became defined, various studies applied public health data to develop physical activity guidelines to achieve and maintain benefits. The promotion of physical activity became a priority on the public health agenda, but did not extend to city planning and design.

From a planning perspective, the dimensions of public health have not fully been explored. In his book, *Toward the Healthy City,* Jason Corburn contends that city planning is only now finding ways to incorporate health into planning policies and programs (Corburn 2009, 198). Embracing a 'health in all policies' approach, recent efforts have concentrated on developing health impact assessments (Douglas et al. 2001; Rajotte et al. 2011), and comprehensive plans have incorporated healthy community policies in cities such as Seattle, Cleveland, and Philadelphia (Godschalk and Anderson 2012).

One of the challenges confronting proponents of healthy communities relates the need for integrating skills, tools, and theory from both planning and public health to attain goals for physical activity. Currently, practitioners from different disciplines seldom interact (Botchwey and Trowbridge 2011, 322). As such, building healthy communities for the future requires cross training and collaboration in reconceptualizing the city as a network of infrastructures to support human and ecological health, as well as physical activity.

2.2.3 Studies on Walking and Bicycling

Several disciplines have conducted research on walking and bicycling in various forms of public open space, identifying access and other key determinants. One of the criticisms of the research in physical activity lies in its limited operationalization of the use of multiple variables across domains in the socioecological model. Studies to date have largely focused on a single domain of physical activity: recreation for leisure time in parks or neighborhood open spaces (Kaczynski and Henderson 2008), or for transportation purposes on public streets and sidewalks (Krizek and Johnson 2006;

Southworth 2005; Dill 2009). Much of this work has been conducted at the neighborhood scale (Trowbridge and Schmid 2013), and few data exist that reach across disciplines to address issues at the community level. A notable exception is the publication of *Active Living Guidelines* by the city of New York (2010), which provides design recommendations for both indoor and outdoor settings to promote activity friendly environments at the project scale. Its collaborative efforts have resulted in development of similar guidelines for projects in other locations (Lee 2012), yet there is a lack of research relating synergies and design strategies beyond the site scale.

2.2.4 Governance and Guidance for Physical Activity

On a national level, the CDC housed in the Department of Health and Human Services, provides information in support of physical activity. The CDC "serves as the national focus for developing and applying disease prevention and control, environmental health, and health promotion and health education activities designed to improve the health of the people of the United States."[17] Two divisions within CDC support physical activity and healthy community design. CDC's Built Environment and Health Initiative, also known as the Healthy Community Design Initiative, is located in its Division of Emergency and Environmental Health. This initiative works to form new partnerships to link public health surveillance with community design decisions and conducts research to identify links between community design and health. Through its Division of Nutrition, Physical Activity, and Obesity, the agency works toward developing policies, guidelines, and environmental strategies for healthy eating and

[17] http://www.cdc.gov/nccdphp/dnpao/

physical activity. Guidelines outlining health benefits for physical activity levels provide recommendations for weekly goals in both aerobic and muscle strengthening activities to achieve health benefits for adults, adolescents, and children.

To accomplish its mission, CDC "supports community-level efforts to reduce chronic diseases, improve health, reduce health disparities and control health care spending." *The Community Guide for Preventive Services*[18] provides information in support of physical activity. An independent task force sponsored in part by CDC conducts reviews of available studies to assess the effectiveness of strategies regarding design, policy, and behavioral interventions. The task force makes recommendations for "strong and sufficient evidence that the intervention is successful," reflecting its degree of confidence that an intervention "has a beneficial effect." The task force recommends the creation of or enhanced access to venues for physical activity. Such changes may include development of walking trails or providing improved access to existing facilities.

Environmental and policy approaches to increase physical activity include both community and street scale land use policy recommendations and practices. In addition to government policies and regulatory documents such as zoning and building codes, strategies include design elements that address: connectivity and continuity of streets and sidewalks; aesthetics and safety of the physical environment; and proximity from residential areas to schools, stores, jobs, and recreation areas. Street scale strategies

[18] http:/www.thecommunityguide.org/pa

include improved street lighting, infrastructure improvements to increase safety of street crossing, street tree plantings, and use of traffic calming devices.[19]

Physical activity plans have been developed on a state and national basis. The U.S. Physical Activity Plan (2010) delineates strategies for physical activity in eight sectors. Statewide plans address physical activity in 43 states (Eyler et al. 2014). A review of these plans found most to be deficient in overarching objectives for land use, transportation, and community design. No apparent relationship between statewide and local plans that promote physical activity was identified.

2.2.5 Physical Activity and Design–Connections to Urban Form

Proximity to destinations (Krizek and Johnson 2006), design of neighborhood infrastructure (Michael et al. 2006), and the potential of local infrastructure to support healthy behavior (Koohsari et al. 2013) depend upon legible urban form. As previously mentioned, most of the studies relating physical activity rely on a cross sectional design analyzing quantitative data. There is a lack of literature providing context in the form of environmental attributes represented in urban design such as lighting, park facility improvements, and street trees (McCormack and Shiell 2011). Through qualitative evaluation, I will explore these factors later in this dissertation as cohesive elements of design in signature projects.

2.3 Integrating Public Health, Planning, and Community Design

In response to goals for sustainable communities, the American Planning Association (APA) issued a report on the role of sustainability in regional, county and

[19] http://www.thecommunityguide.org/pa/environmental-policy/streetscale.html

municipal comprehensive plans (2012). The report outlines eight categories to be addressed in comprehensive plan, emphasizing livable built environment, healthy community, harmony with nature, equity, responsible regionalism, authentic participation, and accountable implementation. Many jurisdictions, such as Clark County, Oregon, have included a health element (Ricklin and Kushner n.d.) as a component of the plan, while cities such as Austin, Texas (*Imagine Austin)* have included health more closely aligned with the sustainable comprehensive plan model. Louisville, Kentucky published their goals for health in *Healthy Louisville 2020,* outlining goals for providing health services, as well as nutrition and physical activity. Although plans may be housed in various government agencies, there has been a significant emphasis on a proactive approach to health and well-being. An emerging trend in policy links biophysical and cultural processes. For example, Seattle responded to health and wellness in its *2100 Open Space Plan,*[20] stating that "in contrast to its twentieth century Olmsted-based park system, [the city] needs a more comprehensive and multi-functional open space vision that preserves the open space and the ecological functions that open space serves" (Griffith 2011, 294). Few policies translate to specific design objectives, with the exception of form-based codes to guide development. In response, this study links strategies at the project scale with policies at the municipal scale to explore consistency between projects and the regulatory framework in which they exist.

[20] http://www.open2100.org/

2.4 SUMMARY

Linking green infrastructure and physical activity offers promise for community planning and design. Concepts of multi-functionality and connectivity permeate literature in green infrastructure, but advances demonstrating the flow between planning and application are missing. Few analytical studies have been done for green infrastructure planning (Sandström 2002; Lafortezza et al. 2013), and best examples at the project scale (Pauleit 2011 et al.) fail to relate implementation and planning.

> "Many commonly cited environmental benefits of urban green space are poorly supported by empirical evidence, adding to the difficulties in designing and implementing green infrastructure programs." (Pataki et al. 2011, 27)

Providing infrastructure in support of physical activity presents an opportunity to bridge ecosystem and human health through community planning and design. In the next chapter, I construct the theoretical framework through a lens of normative planning, synthesizing perspectives from urban ecology and good city form. Presentation of case study theory is followed by methods employed and justification for the selection of study locations.

Chapter Three: Theoretical Framework and Methods

The literature review presented in the previous chapter identified key lines of thought relative to green infrastructure and physical activity, pinpointing gaps in recent research efforts. In this chapter, I outline the theoretical framework and details the research methods used for my inquiry of green infrastructure. My specific interest lies in the potential bridge between planning and public health to design, regulate, and implement strategies to provide opportunities for physical activity. In the following sections, I present an overview of the research, stating the central research question and relative thematic questions. I then summarize the theoretical framework, combining perspectives from normative planning, urban ecology, and good city form. Finally, I outline relevant case study theory, methods employed, and justification for selection of cases.

3.1 Research Overview–Questions and Methods

My primary research question is: how can a green infrastructure network serve as a bridge between planning and public health to design, regulate, and implement infrastructure that provides for physical activity at the municipal scale? Although green infrastructure is a multi-scalar concept, I chose the municipal scale because of the rules, regulations, and decision-making impacts which take place that affect land use planning, design, and project implementation. To tease out the issues for analysis, I selected a significant or "signature" project that exhibits characteristics of good city form, is accessible to a large number of residents, and comprises affordances to promote physical activity. In this way, the implications and influences of municipal policies, rules, and decision-making processes can be unpacked and analyzed in terms of opportunities as well as obstacles encountered at the project level. The agency of the project was examined for its influence at a broader scale in terms of replicable solutions to positively affect change citywide. My research was conceived to investigate how these policies and rules translate spatial boundaries toward realizing goals for healthy citizens in sustainable communities. Four thematic questions are posed relative to the central research question:

1) **Scale:** Do the planning and design strategies and best practices of a signature project translate scale from site to city? What were the influences across cities?
2) **Health:** Did the green infrastructure project consider health in planning, design, and implementation? If so, how?
3) **Power and Collaboration:** What was the role of political power in the regulatory process, and how did key participants collaborate to affect change in terms of city policies and codes?
4) **Measurement:** What performance indicators or relative measurements should be used to define and monitor success from the perspectives of planning, design, and public health?

Research methods largely employ qualitative procedures, incorporating a comparative case study approach. My inquiry involves green infrastructure, as both object and process, as a unit of analysis to explore strategies and best practices relative to opportunities for human physical activity.

Physical activity as a field of study is relatively new, with most research conducted subsequent to the 1996 Surgeon General report that called for further study of potential benefits of physical activity. To date, the body of literature largely consists of cross-sectional empirical studies that do not address the context of the built environment at the community scale. A case study approach to the issues provides a context, depth, and thick description leading to a more thorough understanding of the issues relative not only to the physical environment, but also to the opportunities and barriers presented by current policies and practices from multiple vantage points. My approach is pragmatic, built upon my own experiences from practicing as both a landscape architect and planner. I have drawn on my extensive involvement with municipal plans and processes, interdisciplinary project planning, design, and implementation of works integrating green infrastructure and human physical activity. Admittedly, such a position reflects a bias and disciplinary perspective. Using this professional knowledge partnered with existing theory and my previous case study research led to identification of study boundaries centered on the opportunities and limitations of normative planning. Through a lens of critical pragmatism linking knowledge to action to knowledge, the theoretical underpinnings of the work incorporate urban ecology and good city form with a transdisciplinary approach.

3.2 Theoretical Framework

As discussed in the previous chapter, this research crosses disciplinary and spatial boundaries in two subject areas: green infrastructure and physical activity in terms of both access to and presence of facilities that promote health and wellness. This synthetic approach seeks to ground the concept of green infrastructure as a complex aggregate system composed of overlapping spatial, jurisdictional, and disciplinary boundaries. The theoretical foundation of the research focuses on the pragmatic issues of providing infrastructure that supports physical activity and how that fits into the sustainable city. Rather than testing a single theory, my philosophical framework aligns with Healey (2012) in that most theories are like "an association of ideas, discussions and controversies in discussion with each other," offering a worldview through a particular perspective and orientation (Healey 2012, 336). Therefore, my research draws from normative planning literature, supported by urban ecology and Lynch's theory of good city form. The concepts of communicative action and transdisciplinarity offer insight into collaborative efforts and disciplinary perspectives encountered in both the co-production of knowledge and challenge to accomplish innovative solutions within a normative planning framework. These principles served as a guide in the development of research questions and applied methods. The following paragraphs provide a discussion of how these premises are integrated into my study. The descriptive pattern of the narrative first presents theoretical construct, followed by practical application.

3.2.1 Normative Planning in the Sustainable City

The infrastructure and ecology of a city forms the framework for sustainable planning, relating urban ecology to urban design (Palazzo and Steiner 2011). Historically, city planners acted on cues from urban conditions rather than theories, one being the structure of governance itself (Ryan 2011). Therefore, theory for the practicing planner has largely been shaped by tradition and generalizations of prior experience to predict the consequences of his or her actions (Fainstein and Campbell 2012). From a pragmatic perspective, Schön (1983) illustrated how practitioners "reflect in action," learning in a process of trial and error to evaluate results of practical moves and subsequent consequences within normative design domains. Normative theory largely dictates the process and resulting urban form (Brooks 2002), describing how things should operate. More specifically, normative theories "prescribe what the relationship between the variables in question should be in order to produce results that are deemed desirable" (Brooks 2002, 22). Brooks examines this theory in two subtypes, ethical and functional. Ethical normative theory refers to what is right in the context of an external principle. For instance, a planner may present a strategy for urban trail connectivity using green infrastructure (the action) that would result in improved pedestrian access and safety (the outcome) in reaching the goal of creating healthy active communities (the desired outcome in light of an external principle for health and equity in the city). Functional normative theory requires no external principle; actions are prescribed as they are determined to be the best course of action, or the 'right thing to do' to make something better, faster, more efficient. Gray infrastructure solutions demonstrate the principle in response to technological advances, such as the autocentric emphasis of current transportation systems, moving cars at accelerating speed while typically neglecting needs of pedestrians and cyclists.

Brooks cites the rational planning method as an example of functional normative theory: city planners used rational methods as the prescribed way to do things at the time, without question (no external principle). In the absence of an ethical normative framework, goals, policies, and implementation measures lack adequate justification. Functional normative theory parallels prescriptive physical design, where decisions may be made on little more than designer preference or planning traditions. In a static environment of prescriptive planning, such traditions limit adoption of dynamic strategies to guide urban form.

The rational planning approach taken by Brooks generally represents conventional planning practice. One of the pitfalls of normative theory to influence urban form resides in its lack of appreciation in the complexities involved in planning. Prescriptive solutions may be complicated by overlapping and sometimes conflicting ecological and political jurisdictional boundaries. The need exists for addressing not only the prescribed action, but also its associated processes and outcomes (Forester 2012). In this way, the experiential stories of practice evaluated within the regulatory framework may work to advance planning theory.

Planning as a discipline, however, still faces criticism in its divide between academia and practice. Hall (2002) argues that academics concern themselves with planning theories and ignore practice applications, while practitioners are consumed by the mechanics of planning without theoretical constructs for a deeper understanding of practice (Legates and Stout 2011). Distance between theory and accomplishment may explain the gap between what theories envisions and the reality of what can be brought to fruition in practice (Fainstein and Campbell 2012, 15). To improve the relationship between the two factions, Hall delineated a reciprocal relationship where theory informs and improves practice, and practice both tests and builds theory.

Taking a reflective approach, Forester (2006) challenged planners to observe the practice aspects of governance and environmental policy making to evaluate theory and discover new analytic problems. In this way, applied theory advances professional practice. One issue addressed is the effects of bureaucratic land use controls on urban form and ecological infrastructure. Conventional planning tools such as zoning codes, subdivision regulations, and criteria 'how to' manuals, prescribe design and implementation measures in the best interest of the public health, safety, and welfare. This forms the legal foundation and justification for planning in the United States.

With the intention of promoting public health by prohibiting noxious land uses and separating other uses to protect private property rights on single land parcels, traditional Euclidean zoning largely prohibits mixed use environments that support goals for healthy sustainable cities, such as vitality and walkability (Flint 2014). Provisions for greater open space and limits on the building size and density set forth in 20th century zoning laws were overshadowed by the overarching purpose for separating land uses (Scheer 2013, 321). As a result, the importance of and access to open space was overlooked.

To match the goals for zoning, technical subdivision regulations were developed at the municipal level to set construction standards, including specifications for infrastructure. These included, but were not limited to, sizing and dimensions for sidewalks, lighting, sewer, and water (Scheer 2013, 321). By focusing on the functionality of individual subdivisions, the continuity of the urban fabric was ignored. Infrastructure planning and implementation consisted of single purpose corridors of consumption to connect services from one subdivision to the next. In support of zoning and subdivision regulations, many municipalities developed criteria manuals to guide design and recommend standards for implementation. Guidelines ranged from prescriptive, such as formed based zoning codes, to performance criteria that reflect values to shape development (Dixon 2014). These processes encouraged development, yet did little to realize a mixed–use public realm with multiple land uses. To promote human health, policies must be adopted that change zoning requirements and development guidelines (Frank et al. 2003). Furthermore, a reconceptualization and understanding of urban infrastructure must be recognized as a contribution to sustainability. My study explores green infrastructure as an integral component in physical planning, as part of an urban ecological infrastructure system.

3.2.2 Urban Ecology – Planning and Design Through Green Infrastructure

Green infrastructure promotes planning of multi-functional landscapes that combines nature and culture in a systematic approach toward urban sustainability. Study of green infrastructure has been criticized for its lack of a particular theoretical foundation beyond the seminal work of Benedict and McMahon (2006) in outlining the concept and its potential applications (Hansen and Pauleit 2014; Mell 2009). Production of knowledge in green infrastructure draws from several disciplines including but not limited to ecology, landscape architecture, urban planning, and engineering. It is informed by ecological principles, such as multi-functionality, connectivity, ecosystem services, habitat connectivity, and complementarity (Pauleit et al. 2011, 283). Two of these principles, multi-functionality and connectivity, form the basis of providing an urban ecological infrastructure that supports physical activity. Urban ecology integrates these components, among others, across a spatial gradient, combining humans and nonhumans as part of "functional and just" ecosystems (Palazzo and Steiner 2011, 2). This differs from traditional ecology in that it revises the epistemological binary of people versus nature by embedding humans as an integral part of the environment (Light and Katz 2006). Drawing from the interdisciplinary field of landscape ecology, urban ecology articulates relationships among landscape functional processes, structural patterns, and scales (Ahern 2010; Forman 2014). Research in urban water resources and hydrology (Marsalek et al. 2008; Ahern 2010) utilized a form and process relationship between patterns as spatial entities and processes in terms of ecosystem services to link water resources with city planning and urban design. Similarly, this application provides a means to explore green infrastructure as a component of both ecological infrastructure and urban form (green infrastructure as object) and as dynamic process in both an ecological and regulatory framework (green infrastructure as process).

From a planning perspective, the concept of urban ecology guided my study in the following ways. Ecological planning affords the opportunity to synthesize the physical health of the ecosystem with the social and cultural aspects of providing infrastructure for promoting human health. The unrealized potential and capacity of multi-functional landscapes transcend the traditional forms of the built environment, offering a conceptual link from physical activity not just to infrastructure, but also to biophysical processes. Here design becomes both representational of good city form and performative in its biophysical functions. It employs an interdisciplinary framework that integrates humans and nature across multiple scales. Within this context, it encourages a transdisciplinary approach to advancing green infrastructure, involving collaboration between academy and practice. Using an integrative approach where urban infrastructure functions as a system comprised of multi-functional green infrastructure and gray infrastructure encompasses a broad network to support functional and cultural services, including physical activity.

One of the challenges in interdisciplinary research lies in a lack of common understanding of integrative research concepts. Integrative projects are comprised of interdisciplinary or transdisciplinary research efforts in which new knowledge and theory results from a synthesis of disciplinary knowledge (Tress et al. 2006, 17). Without a common understanding of concepts and definitions of terms, however, it becomes difficult to compare research results or communicate ideas among researchers (Tress et al., 15). Using the concept of urban ecology, Forman (2014, 4) illustrates differing perspectives between planners and ecologists. In his view, planners concentrate their efforts on providing human environmental amenities while minimizing adverse impacts. Ecologists generally study patterns of species and their habitats, including interacting factors such as flows of materials and patterns of change. He points out that an urban ecological framework is useful by many disciplines, focusing on different interacting factors (Forman 2014, 4). For instance, recreation and aesthetics generally address people-organism interactions, while public health highlights built structure-people-organisms interactions. These associations appear to be logical in building a research agenda by discipline, but not yet a combined approach across disciplines.

An ecosystem approach to planning relies on urban ecology, applying a range and order of spatial boundaries and scales to characterize metropolitan areas. This ecology constitutes a relationship between human society and the environment (Hancock 1985). Cities represent constructed ecosystems that supply local human habitat in terms of materials and flows of air, water, energy and food (Barton 2005, 243). Hierarchy is a critical component of urban ecological planning in both extents. Boundaries, depending on purpose and perspective encompass fluctuating and overlapping jurisdictions (Vasishth and Sloane 2002). Both natural and socially constructed limits provide a frame of inquiry in magnitude and scale. Forman (2014, 12) delineates nine levels of scale: 1) megalopolis; 2) urban region; 3) metro area; 4) city; 5) major land use type; 6) neighborhood; 7) block; 8) building; and 9) microsite. Forman's method of inquiry combines the differing institutional and natural scale constructs pinpointed in the MEA assessment (see Figure 2.4), yet does not address the problems that the synthesis may create.

The scale of study of a particular object or process determines its form and function (Forman 2008; Forman 2014; O'Neill et al. 1986). Three types of interactions describe the relationship of scale. The levels of detail above and below situate the object being examined. Characteristics at a broader scale control and bound the object within in a particular context. Attributes at the next lower scale help to explain the internal functions of the object; and at the same scale, other objects collaborate or compete with object considered. In an urban planning context, the state in its provision of laws and the region in its physical boundaries and processes bound the city as an object of study. Within a project, circulation and flows act as internal processes. Projects are comparable to similar works at the same scale.

Critical reflection of spatial composition pairs the action or performance measure to its comparable scale. From an ecological planning and design perspective, two examples illustrate the issue. One problem lies in evaluating planning issues directed at a landscape scale by using metrics intended for a more fine-grained project analysis. Advances made in regional scale green infrastructure benefitted from the ecological theory developed in seminal works by Ian McHarg and Philip Lewis (Wenk 2002). McHarg, whose firm designed the master plan for The Woodlands, convinced his client to adopt a natural drainage system, where landscape provided a green framework to treat stormwater runoff and recharge the aquifer (Yang and Li 2011, 15). McHarg was criticized for his master planning efforts of integrating nature and culture, due to errors in grading design and engineering at the site scale (Wenk 2002). Subsequent studies (Yang and Li 2010; Yang and Li 2011) found open surface drainage McHarg's landscape drainage solutions to be effective, and that later phases of the project did not follow natural drainage strategies. To translate scale effectively, there needs to be an understanding as to who is responsible for what action at a particular scale, and continuity to provide smooth transitions.

The second example works from fine grain to broad scale. Landscape architects and allied professionals have faced criticism where rain garden design and implementation functions on site (Wenk 2002, 200), yet such strategies are isolated or functionally non-contributing as a component within a neighborhood or municipal green infrastructure system. By situating policies and procedures for examination at the municipal scale where decisions are made, I evaluate the translation of scale in two ways: 1) from the policies and procedures at the municipal scale that advocate green infrastructure to support planning and design decisions to facilitate physical activity and 2) by identifying site design issues in terms of the opportunities and limitations for green infrastructure, particularly with regard to resilience.

Strategies for resilience in terms of a city's ability to adapt and respond to changing circumstances become an integral component in rethinking the future (Beatley 2012, 117) of ecological infrastructure. In a relational framework, resilience must also be considered in view of planning and designing infrastructure supportive of public health strategies (Corburn 2013, 19) to minimize chronic diseases.

3.2.3 Good City Form

Kevin Lynch's theory of good city form proposes that physical planning can create safe and holistic community environments (Banerjee and Southworth 1990). Urban form portrays the physical appearance of the city as well as its infrastructure (LeGates and Stout 2011). This notion is predicated on the walkable neighborhood unit of Clarence Perry, Ebenezer Howard's garden city concept in which residents had convenient pedestrian access to services and local destinations, and the walkable superblock concept advocated by Clarence Stein (Banerjee and Southworth 1990). In his research, Lynch explored how the public perceived spatial relationships of urban form and organized their day-to-day surroundings. He challenged planners to address form at the city scale, stating that the "urban landscape can and should be just as meaningful and delightful as the natural landscape and should be designed to be so" (Banerjee and Southworth 1990, 33). Both Lynch and McHarg argued for considering the city in regional context, emphasizing that social value be cultivated through an ecological approach to urban design (Spirn 2011). Even though Lynch's good city form is often associated with visual quality and aesthetics, he emphasized the importance of connection between the forms of places and the values and needs of its users.

In his book *A Theory of Good City Form* (1981), Lynch described cities as expressions of core human values and examined how values should serve as a guide for good physical and spatial design (Gold 2011, 293). In this instance, the "rightness" of the outcome is good city form that represents the values and needs of its citizens–particularly the need to promote health and equity in the city. Mainstreaming green infrastructure as a component of good city form serves to move from niche to norm in both city planning and project design. As Spirn (2011) expressed, urban ecology contributes to urban design in its attention to form and detail, and design guides development to shape the future.

Acknowledging that physical form is but one aspect of city planning, Talen and Ellis (2002) call for planners to have "clear, durable standards for successful outcomes" (36), in establishing a commitment for good city form. Their failure to define good city form notwithstanding, they claim that a lack of theory for such form has resulted in urban sprawl and fragmented cities, where community extends beyond jurisdictional boundaries, with the only apparent connectivity ordered in the physical infrastructure of roads, pipes, and rails. Talen and Ellis discuss the need for theory development by offering several perspectives, but offer no clear direction for the development of theory they request. Lynch, in a more decisive manner (2009; 1981; 1960), outlines nine characteristics, or performance dimensions to guide spatial form in order to navigate the city. These dimensions are general in nature, but designed to be specifically applied to existing and proposed urban forms. Highlights include: regard for identifiable and measurable form; a need for consistency in levels of generality; connection to the important goals and values of any culture; and the ability of dimensions to address qualities that may change over time. Lynch suggests that the failure of establishment of good urban form rests on the lack of understanding of 'nonformal' features such as culture and politics. Both planner and architect, Lynch built his image of the city by crossing boundaries of planning and design, looking at issues of culture and structure collectively.

Another obstacle to good city form relates to the previously discussed constraints of zoning and land use controls. Prior to the promulgation of such laws and rules, bureaucratic influences were limited in both scale and scope (Wenk 2002, 175). Collaborative team efforts between newly emerging design and engineering professions resulted in innovative, integrated solutions. Urban parks, such as Boston's Fens, were designed as part of a larger integrative infrastructure system that encouraged human use (Wenk 2002, 176). The adoption of land use controls separated uses, with rules and regulations often resulting in mediocre developments (Hall 2002). One remedy proposed was a hybrid approach to zoning which favored performance over prescription to guide land use as well as urban form. Attempts to provide such flexibility through zoning overlay districts have produced mixed results.

The role of sustainability in city form is addressed in Vasishth and Sloane's account of an ecosystem approach to revisioning the city (2002). In response to a system that sets artificial boundaries to define levels of responsibility, they suggest an ecosystem approach to city planning. Translating scale and boundaries provides a more holistic approach to planning, in comparison to the ecological and sociological movement that took place in Chicago in the 1930s. By looking at ecological systems, planners and designers are driven to consider different sets and types of boundaries, and the man-induced impacts to natural systems. In concert with city form, this theory puts an emphasis on place. Focusing on place recognizes the need to address the dynamics of time and scale in the ecosystem and in the city, and allows us to distinguish between structures and functions. Lynch reiterates this need for flexibility in his distinction of continuity between time and space. This distinction of time and space becomes particularly important when analyzing the plans and processes of projects consisting of multi-year phases and extended maturation of the project through its ultimate buildout.

3.2.4 Communicative Action–Planning vs. Plans

Communicative action constitutes a planning theory in which “actors in society” attain common understanding by coordinated actions in the form of reasoned argument, cooperation, and consensus (Habermas 1984, 86). This contrasts with methods of strategic action where individuals pursue their own private goals. The planner’s role here becomes reflective, opening up the opportunity for sharing of information and public participation to reach consensus, rather than just a technical expert. This theory assumes the position that planners must seek strategies that further the common interest, shifting away from the normative theory of prescriptive planning where action responds to how things ought to be done. Forester extends the communicative approach a step further, linking planning and administrative practices to influence and power (1989, 6). His focus concentrates on planners’ responsiveness to situations in creative ways through communication, instead of preconceived routines.

For the purposes of my study, I contend that communicative action is not necessarily in opposition to normative planning. It serves, in many instances, as a component of normative planning in the process of formulating plans. Plans function as tools to make decisions (Hopkins 2001). Accordingly, plans and plan-making at the municipal level serve two main functions: 1) a collaborative process to establish overall vision, policies and strategies to guide growth and development in the city; and 2) the production of plan as object, which upon completion or sometime thereafter, can be assessed for meeting its intended outcomes. Planning, as an interactive process, is distinguished from the objects or plans produced. In his assessment of municipal code reforms to minimize sprawl, Norton (2008) identified the content of a plan in terms of its policies, evolving from collaborative action of the contributors in development of the plan. In this model, it assumes equal participation of disciplines in the formation of the plan, without regard to the power of decision-making.

One aspect of my study examines the role of key participants and the relation of power–how the concept of rationalization is used to explain the use and misuse of rational rhetoric, as referenced by Flyvbjerg (2001). The power of politics and the power of the market have an impact on who shapes good city form, and how resources are allocated for green infrastructure investment. Power exists not only in the communication with and between market forces and those in political power, but in the planning process itself. Planners frequently have little control over the implementation of plans that they produce (Forester 1989, 67), sometimes resulting in unintended consequences outside the goals of the original plan. Plans receiving approval through a municipal process may not always be the best plans made. A traditionally rationalist justification is necessary for a plan to be approved, and once approved is not generally arguable (McCallum 2008, 329). In other words, further implementation under the plan does not usually require additional justification or input from others.

This places power in the plan as well as its process, minimizing the opportunity for what Watson (2003) refers to as "conflicting rationalities" by acceptance of normative procedures. The judgment of what constitutes good city form relies on "how equitably the costs and benefits of urban life are distributed among an area's residents" (Hack 2012, 38). Decisions regarding conformance to urban form have direct consequences on the physical, economic, and social capital in our cities. These decisions, in turn, modify the planning process. In this study, I investigate the role of the power of decision-making in the plans and processes relative to green infrastructure and physical activity at both the project and municipal scale. Using Flyvbjerg's "power of example" (2001), I explore the power of the project to translate scale in shaping a preferred outcome at the municipal level: public health and well-being facilitated by green infrastructure policies and strategies that promote physical activity.

3.2.5 Transdisciplinary Approaches to Green Infrastructure

Transdisciplinary theory has been recommended as a foundation for green infrastructure research and practice (Ahern 2010, 136; Tress et al. 2006) for its integration of academic and non-academic participants, decision makers, and citizens. Envisioned as an iterative and interactive approach to research, it relies on the common understanding of concepts from multiple perspectives to create new knowledge. This co-production of knowledge is challenged by disciplinary approaches in the ways questions are posed and research is conducted. My approach embraced the multiple perspectives toward creating new knowledge, with questions posed from a physical planning and urban design perspective. Knowledge production in this research linked local knowledge with academic knowledge and discipline based outlooks.

Interdisciplinary efforts, similar to transdisciplinarity in integration of disciplines that cross boundaries toward a common research goal, differ in the participation of either academic or non-academic disciplines (Tress et al. 2006, 17). Many projects in professional practice involve either multi-disciplinary (parallel efforts) or interdisciplinary (integrative efforts) teams to solve problems. For example, engineers, ecologists, landscape architects, and planners may form a team for a green infrastructure project. Similar to transdisciplinary, an interdisciplinary approach requires each team member look beyond a particular professional discipline to integrate knowledge to collectively solve problems. Figure 3.1 depicts scalar levels of integration.

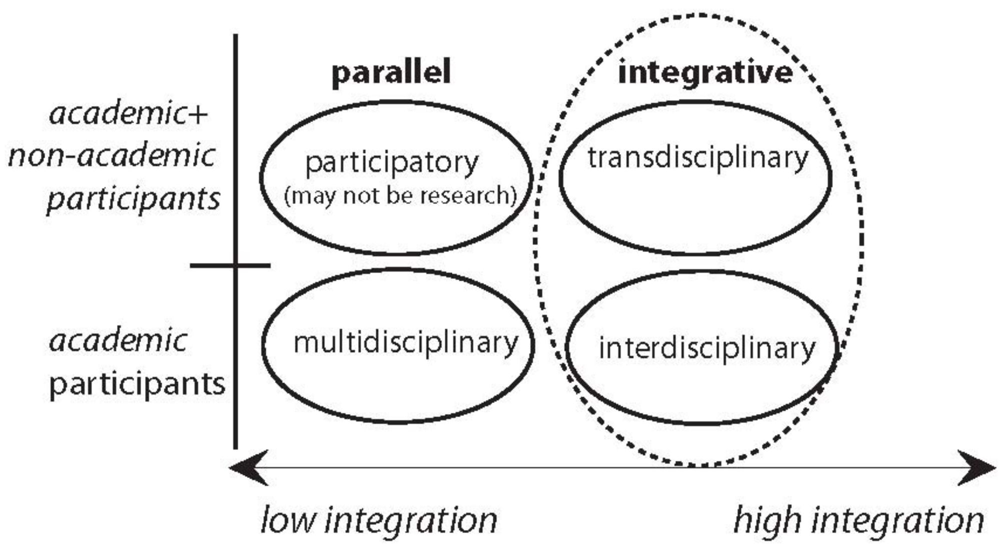

Figure 3.1 Degrees of disciplinary integration and stakeholder involvement
(Tress et al. 2006)

The cross connections in Figure 3.2 form the nexus of the transdisciplinary agenda and highlight unique perspectives that exist across disciplines.

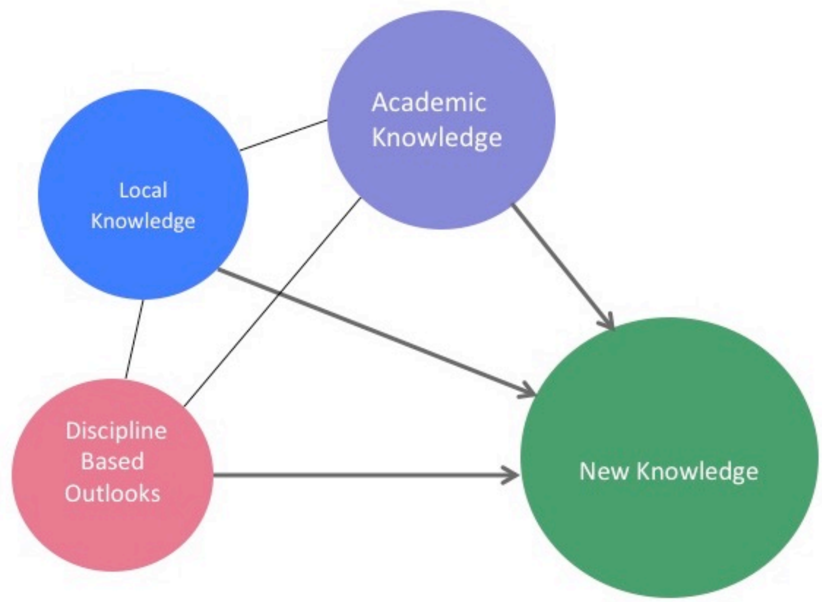

Figure 3.2 Transdisciplinary Approach to Knowledge Production

For successful transdisciplinarity, each discipline must have an understanding level of other perspectives and respect for both disciplinary and transdisciplinary objectives. My research aims toward an understanding of planning, design, and public health perspectives to provide meaningful ways to link planning and design with public health through both ecological infrastructure and urban form.

3.3 Research Design–Structure of Inquiry

Research design begins with a purpose of study relative to a particular topic. In my study, the purpose of study is an exploration of the power of the project to realize city goals. Based on the goals of the research and orientation of the researcher, the structure of the inquiry identifies approaches and methods, which most unambiguously answer the research question (Ridenour and Newman 2008, 18; DeVaus 2001, 9). According to Creswell (2009, 5), the design involves the intersection of research approach, philosophical worldviews, selected strategies of inquiry, and research methods. In terms of approach, quantitative research largely tests objective theories in analyzing measurable relationships among variables (Yin 2009; Creswell 2009). Qualitative inquiry generally involves phenomena as a way to understand meanings or events by individuals in a particular context (Creswell 2009; 2007). The two approaches are not necessarily diametrically opposed, as Creswell describes a range of perspectives across a continuum. As DeVaus contends (2001, 9), a particular research design should not be pre-determined as quantitative or qualitative.

The appropriateness for using a case study applies "in situations where the subject of research is complex and involves the interaction of both human and biophysical relationships" (Deming and Swaffield 2011, 80). My research interests address how green infrastructure may be used to promote physical activity at the municipal scale, involving both human and biophysical relationships.

In a case study, the unit of analysis is the case, a "phenomenon of some sort occurring in a bounded context" (Miles et al. 2014, 28). Utilizing a comparative case study approach, I explore the capacity of green infrastructure to promote physical activity. The term 'case study research' is associated with a variety of meanings and approaches across disciplines of academic research. Creswell (2007) defines it as an inquiry of approach for qualitative study within a bounded system. Yin (2009; 1998) describes the scope of a case study as "an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (2009, 18). Some argue that case study is not so much a methodological choice but a strategy for research (Yin 2009), or simply a choice of what is to be studied (Stake 2005). Most scholars agree that case study is a strategy involving a 'case' as the object of inquiry – "the unit of analysis by which we collect information" (DeVaus 2001, 220) to address research questions that seek the answers to 'how' and 'why' regarding particular phenomenon studied as a specific event or over a period of time. These varying perspectives contribute to the complex nature of case study research.

Case studies have been widely used in the urban planning and design professions through written and visual documentation of projects as a method of storytelling to communicate knowledge and advance theory (Francis 2001, 1999). Case studies can be used to "build on reflective practice by incorporating ecological research and design theory" (Steiner 2011a, 337) toward the goal of creating innovative solutions for sustainable cities. Francis' *Case Study Method for Landscape Architecture* relies primarily on theories of Robert Stake and Robert Yin.

My research approach is based a synthesis of theoretical case study perspectives, incorporating tenants from Stake, Creswell, Yin, and Francis. The approach employed is illustrated in Table 3.1.

Table 3.1 Synthesis of Case Study Perspectives

	Research Approach/Strategy	Relevance to Research	Advocate
Type of Research Question	Exploratory	Synthesis of planning and public health is relatively new phenomenon when juxtaposing physical activity and green infrastructure to biophysical processes	Francis
Degree of Problem Definition	Key variables not defined	Purpose of exploration intends to identify issues, which may be key variables for future research	Stake, Creswell, Yin, Gerring
Type of Case Study	Collective (multiple instrumental cases)	Comparison of selected cities intended to test existing normative theory and help build theory in new area of study; multiple perspectives on similar issues.	Stake, Creswell
Cases within Study	Instrumental	Understanding of both context and issues	Stake, Francis
Case Selection	Purposive sampling, guidelines for selection were flexible enough to avoid lack of variety to inform particularness of case	Cities selected where strides have been made to bridge public health, planning and design.	Stake, Francis

The research design for this study engaged a comparative case study analysis. The multiple case study approach has been found to strengthen research findings more than that of a single case (Yin 1998). Essentially, a collective or multiple case study examines a phenomenon as an extension of the instrumental case to several cases (Stake 2005, 445). A multiple case study may be effective in synthesizing patterns and principles found across cases (Francis 1999, 10), consistent with my goals in this analysis to identify patterns to compare and contrast emergent themes across the cities selected for study. Francis' method has been used in both research and in practice as a process organized to document the successes and failures in landscape architecture design projects (1999, 14), although in practice he mentions that few practitioners are analytical in post occupancy evaluation. Practitioners also face criticism in representing case studies as anecdotal "war stories" (Windhager et al. 2011). Employing a more formalized approach, my intention is to demonstrate the use of the case study, in part, as an effective method to improve design practice through post occupancy evaluation. Interviewing actors involved in the process informs both site analysis and municipal planning framework.

3.4 Case Study Identification and Selection

The project is comprised of two phases, the first being the selection of cities for case study. This process began in 2012 with a comparison of U.S. cities recognized as 'green' from one or more of several perspectives. Sources include both research publications and popular gray literature: 1) Greener Ideal–ranking of the five healthiest and green cities in America; 2) U.S. and Canada Green Cities Index–a research project by Siemens Economic Intelligence Unit, ranking the performance of 27 cities across nine categories to measure and compare environmental performance; 3) American Fitness Index, 2012 edition–ranking of the top 50 U.S. cities for personal and community health indicators, utilizing Metropolitan Statistical Area (MSA) definitions provided by the Office of Management and Budget based on U.S. Census Annual Estimates of Population; 4) EPA–representative case studies in U.S cities for green stormwater management solutions in particular contexts; 6) Greenprinting, Trust for Public Land–

Selected references of case studies that have used Greenprinting for long range planning; 7) Mother Nature Network–list of top ten green U.S. cities; 8) 25 Active Living by Design Community Partnerships–research publication evaluating a list of physical and policy projects; 9) Green Infrastructure Case Studies–from American Planning Association planning report identifying green infrastructure initiatives in U.S. cities; and 10) Forbes–Report on America's top ten healthiest cities. From this preliminary analysis, several cities were identified as potential candidates for consideration.

Criteria guiding selection upon preliminary analysis includes: existence of city-wide functional master plans for green infrastructure, greenprinting, and parks; best practices manual for stormwater management/green infrastructure; a reported low physical inactivity ranking on BRFSS annual report, as well as consideration for obesity ranking; and a demonstrated connection between planning and public health, as reported by American Planning Association (Ricklin and Kushner n.d.). Other important factors in the selection process were comparable city populations and project types.

Upon review of candidate cities for final selection, consideration was given to ease of access, as well as the context and unique qualities of alternate selection (Stake 1995, 4). Another criterion related the strength and consistency among cities to facilitate comparison (Wheeler 2008). Four cities were selected for case study. They include: Austin, Texas; Denver, Colorado; Louisville, Kentucky; and Portland, Oregon.

3.4.1 Selected Projects

Candidate project types include mixed-use developments, parks, utility corridors, greenways and trails, and stormwater management areas. The process of selecting the project in each city involved reviews of: award winning projects from professional organizations such as APA and American Society of Landscape Architects (ASLA); Landscape Architecture Foundation (LAF) and Urban Land Institute (ULI) case studies; and Environmental Protection Agency (EPA) green infrastructure case studies. Preliminary interviews with professional consultants in the respective study locations and site visits to each project were also conducted prior to selection. Two of the projects (Mueller in Austin and Lowry in Denver) are urban infill mixed-use developments, where former aviation and military installations were redeveloped with open space and pedestrian/bicycle networks. Criteria for selection are represented on Table 3.2.

Table 3.2 Criteria for Case Study Selection

	Criteria for Consideration	Data Source
City Scale	Green Infrastructure Plan	City Published Data
	Sustainability Office or Master Plan	City Published Data
	Comprehensive Plan Element for Health, Green Infrastructure	City Published Data
	Greenprinting Plan	City Published Data
	Pedestrian Master Plan	City Published Data
	Bicycle Master Plan or non-motorized Mobility Master Plan	City Published Data
	Best Practices Manual for Stormwater Management/Green Infrastructure	City or regional published data
	Low Physical Inactivity Ranking on BRFSS	Centers for Disease Control and Prevention Data
	Low Obesity Ranking on BRFSS	Centers for Disease Control and Prevention Data
	Connection Between Planning and Public Health	American Public Health Association National Association of City and County Health Officials: Local Health Department Participation in implementation of recommendations from *The Guide to Community Preventive Services*
	Funding Sources in support of green infrastructure and/or physical activity	EPA, Robert Wood Johnson Foundation, Land and Water Conservation Funds, Trust for Public Land, The Conservation Fund
Project Type	Greenway	Parks Department Data
	Urban Trail	Public Works, Transportation and Parks Department Data
	Mixed Use Development	Urban Land Institute, Congress for New Urbanism, Local Planning Organizations (APA and ASLA Chapter published information)
	Park	City Published Data, National Recreation and Parks Association Data
	Urban Forest	City Published Data
	Stormwater Management Area	City Published Data, ASLA, American Water Works, APA
	Utility Corridor	City Published Data

The other two projects (Waterfront Park in Louisville and Eastbank Esplanade in Portland) are waterfront park developments that portray pivotal roles in the revitalization of the river in each city. Both projects are representative of public space interventions with transportation infrastructure. Waterfront Park illustrates the concept of Underspace intervention, as the park passes under the Interstate 64 freeway, accessible from both sides of the corridor (Loukaitou-Sideris et al. 2013). The Eastbank Esplanade embodies a New Path project where connections are created for non-motorized travel between areas interrupted by infrastructural projects–in this case the Interstate 5 freeway. All projects selected portray significant or signature works that are well known, frequented by and accessible to many, and illustrate the visual and functional importance of urban ecological planning and green infrastructure through innovative design solutions.

3.4.2 The Importance of Signature Projects in Research

Signature projects are unique. Each represents an iconic place that combines private spaces in the public realm that convey a sense of urbanity (Healey 2010, 123). This quality relies in part on the practice of innovation. Forsyth (2007) describes the concept in two dimensions. The first is invention: the discovery of new ideas having far reaching potential. Secondly, the new ideas are adapted and assembled so that "they may be applied in practical ways" (Forsyth 2007, 463). In this sense, innovation becomes replicable. Concepts and strategies successfully implemented in one location may be adapted to another in its particular context.

Forsyth describes innovation in six domains: style; project types; process and engagement; formal/functional analysis and representation; ethical, social, and cultural analyses; and innovations in collaboration with other fields (Forsyth 2007, 469). My research lies within three of those domains. First, style exhibited through built multi-functional green infrastructure may represent innovative design through urban ecological infrastructure. The combination of physical activity infrastructure in formal representation can demonstrate new techniques for representing public space. More importantly in the study of green infrastructure and its application, collaboration with other fields may represent the transferability of concepts among disciplines.

The qualities of innovation serve a critical role in advancing design in practice. Opportunities realized and challenges encountered in both project development and post occupancy experience provide excellent learning tools.

3.5 Methods for Data Collection and Analysis

The methods in my study are generally based on qualitative procedures and incorporate three methods of investigation. These include: 1) a collection of background data and documentation of green infrastructure and significant projects in subject cities, as well as current rules and policies that direct the planning, design, and implementation of green infrastructure and physical activity; 2) field work to document existing conditions on the significant project sites; and 3) interviews of key participants in the process–designers of the significant projects, agency personnel from planning, public health and city administration, and representatives of special interest groups identified in the interview process. The following paragraphs outline procedures and methods for the second phase of study.

3.5.1 The Plans

Plan review and evaluation consists of plans at both the municipal and project scale. Municipal plans include each city's comprehensive plan and citywide, often referred to as functional or departmental, master plans for parks, green infrastructure, and watershed protection. Project plan data and analysis encompass plan review, documentation of site plan approval, and ancillary materials such as permits and public hearing records, and on-site observation for plan to meet its intent for green infrastructure and physical activity. The following paragraphs more fully describe the data collection and analysis for plans at the municipal and project levels.

The plan review and evaluation intends to serve two functions. The first assesses the extent that green infrastructure and physical activity are referenced in the comprehensive plan and citywide master plans for parks and recreation, watershed protection, and green infrastructure. Secondly, it explores the interrelationship of green infrastructure and physical activity as it is referenced across plans. This information is then compared to findings in the signature project analysis for green infrastructure and physical activity, and with interviews conducted in each of the four cities relative to opportunities and challenges for implementing green infrastructure that promotes physical activity. The crosschecking and triangulation of the plans, interviews, and project data assist in identifying emerging patterns in each city, and are then compared across cities.

Municipal plans evaluation encompasses both vertical and horizontal consistency (Norton 2008), identifying the presence and interrelationship of green infrastructure, health, and physical activity. Conceptually, vertical consistency requires that local planning be consistent with particular state planning mandates, such as comprehensive plan elements. This hierarchy extends to the influence of federal mandates on local plans. Internal horizontal consistency refers to the extent in which policies and spatial characteristics for green infrastructure, health, and physical activity appear to be present and compatible across citywide master plans prepared by and for governmental agencies within the city.

In order to develop criteria for plan review, previous studies were examined for content analysis and municipal plan quality. Berke and colleagues (Berke et al. 2006) identified conceptual dimensions that delineate the quality of different components of the plan, including the quality of goals, policies, and fact base. Hopkins (2001) expanded the plan quality concept by including external validity–how the scope and coverage of a plan fits uniquely local circumstances. Berke added plan proposals to the matrix, including spatial designs, implementation, and performance monitoring (2006, 70). In his evaluation of comprehensive plans and zoning ordinances in central Michigan, Norton's (2008) approach went beyond the concept of plan as product, assuming the plan to be a communicative policy act. He emphasized the need to distinguish between the policy focus of a plan and the way in which it is conveyed (Norton 2008, 432). Continuing the evolution of plan analysis, Bunnell and Jepson (2011) compared four qualities to assess the communicative and persuasive qualities of plans, setting forth criteria of what a plan should contain. Although each study referenced focused on different aspects of the plans, evaluation protocols were similar in that they each consisted of ordinal measures, with criteria ranging from 30 to 60 items. Another similarity among the studies was the examination of municipal comprehensive plans.

To situate content analysis of functional plans within the context of this study, I reviewed two other documents related to environmental land use and planning, and physical activity. Randolph (2004) outlined an interdisciplinary approach to environmental land use planning and management, but his analytical methods focused on the interrelationship of physical site components rather than analysis of plans. Component descriptions of environmental land use planning were used to build evaluation criteria for analysis. A study of involvement by public health professionals in the development of pedestrian plans in North Carolina (Evenson et al. 2012) explored the association of aspects of the plan in terms of health–vision, goals, identified programs, and evaluation. The functional plan analysis was divided into five sections to compare the content of 46 plans throughout the state: presentations of plan contents; vision, goals, and policies; information base and content; plan proposals; and plan implementation. The structure and content of this evaluation served as a basis for building criteria for review of functional master plans.

The evaluation protocol is tailored to fit the research questions in the study, focusing on green infrastructure and physical activity. Plans reviews include both plan content and consistency. Plan content elements include: presentation of contents in terms of authorship and articulation of purpose, goals, and policies; fact base and content in terms of history and current conditions; plan proposals of spatial design; implementation timetable for proposed actions; and reference to other municipal plans. Plan consistency review is comprised of five elements: vertical mandates from federal and state agencies; discussion of vertical coordination with state and federal agencies; horizontal consistency addressing intergovernmental coordination with consistent and mutually supportive policies; internal consistency linking plans within the jurisdiction; implementation consistency among plans; and other implementation mechanisms.

3.5.2 The Projects

The purpose of the project review serves two purposes: to evaluate the plan in meeting its intended objectives for green infrastructure and physical activity as represented in the built project; and to assess connectivity in non-motorized mobility routes for bicycle and pedestrian flows within and beyond project limits contributing to a green infrastructure system. Plans were acquired from municipal agencies and professional design consultants charged with the planning and design of the signature projects. Additionally, on-site evaluation is comprised of two modes of travel, using two audit instruments. Each audit is conduct first by bicycling through the project, followed by walking to assess ease of movement and accessibility. Initially, the New York Center for Active Design Urban Design Checklist[21] assesses overall circulation patterns and relationship of major project components. The Physical Activity Inventory Form (Winslow 2010), updated to include green infrastructure components, specifically addresses site components by project segment, such as access, comfort and safety, connectivity, and coherence. Interviews with key participants involved in the project further informed project analyses.

3.5.3 Interviews with Key Participants

Forty-four semi-structured interviews were conducted between September 2013 and November 2014 with persons from both the public and private sectors, including personnel from local agencies and professional consultants. The protocol consists of five areas of inquiry generally aligned with thematic research questions of scale, health, power and collaboration, and measurement. The semi-structured format permits the

[21] www.centerforactivedesign.org

interview to stay focused, yet allows for respondent(s) to relate stories and personal experiences about processes and projects. The questions are structured on an Appreciative Inquiry approach (Flora and Flora 2008), building on positive assets of programs and initiatives. Constructive discussion included both successes and challenges of policies, plans, and strategies at both the municipal and project levels.

Selection of interviewees was initiated in discussions with experts in the respective fields of planning, landscape architecture, and public health who were known to me or referred by other professional consultants. Initial contacts then referred me to persons in each of the four cities. This occurred both prior to and during the interview process. As in the snowball sampling method described by Morgan (2008) early research respondents act as sources to locate other potential participants who had worked on the signature project(s). Morgan cites a distinct risk of capturing a biased subset of potential participants through this method. In this study, however, the subset was indicative of the collaborations among participants on the signature project and other projects and initiatives, producing information relative to networking beyond the signature projects and immediate environments.

One of the strengths in the design of the collective case study compares across cities in an effort to minimize such biases. Discussions and in some instances, field visits to project sites were initiated by participants prior to interviews to provide an introduction to their perspectives relative to green infrastructure projects issues in subject city. These meetings provided common references that were helpful in the interview sessions. Once interviews were scheduled, Institutional Review Board (IRB) Consent Forms were emailed to respondents, signed, and copies distributed to interviewee and project file. When requested, a copy of the interview guidelines was made available to respondent prior to the interview.

Interviews were conducted in person where feasible, or by phone, digitally recorded, then transcribed. During the course of the interview, I took notes to compare my initial perceptions with recorded data. Additionally, I maintained a journal throughout the process, noting perceptions, questions, and references given for data sources, as well as documents acquired, after each interview.

Analysis of transcripts and coding process generally follow process identified by Tesch (1990) as documented by Roberts (2010), in an effort to systematically analyze textual data. This process consisted of six steps: 1) transcript reading; 2) clustering of data by city; 3) organization and coding of responses; 4) review of total transcripts and final coding; 5) across case review and comparison of interview analysis; and 6) review of transcripts to review validity of findings.

A summary of interview population statistics is provided in Table 3.3. Figure 3.2 illustrates the composition of interview respondents by classification.

Table 3.3 Summary of Interview Population

	Austin	Denver	Louisville	Portland	Total
INTERVIEW SETTING					
Total formal interviews (no. of persons)	14	13	9	8	44
Interviews conducted in person, recorded	13	9	8	3	33
Interviews conducted by phone, recorded	0	3	1	5	9
Interviews conducted in person, not recorded (by request from respondent)	1	0	0	0	1
LENGTH OF INTERVIEWS					
30 - 60 minutes	5	4	2	2	13
1 - 2 hours	9	9	7	6	31
RESPONDENTS					
Respondents with municipal agency affiliations	10	5	6	4	25
Respondents with regional or county affiliations	0	3	0	1	4
Respondents working in professional consulting business	3	6	0	3	12
Respondents affiliated with signature project	6	7	3	2	18
Gender of respondents: number of females	6	3	3	3	15

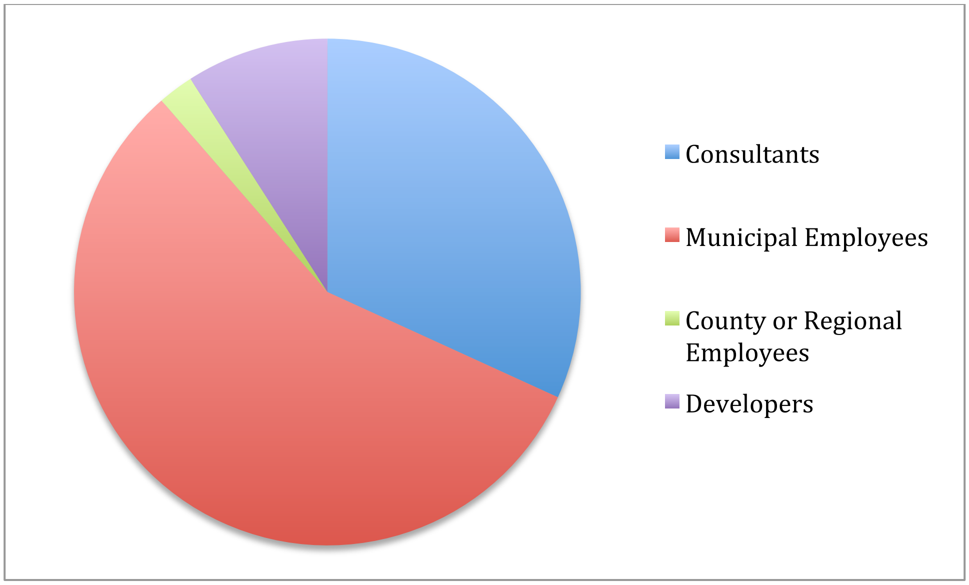

Figure 3.2 Composition of Interview Respondents by Classification

3.5.4 Sequence of Analysis

From the three sources of data collected–municipal plans, interviews, and site reviews–patterns are identified at both the municipal and project level by city. Projects were not directly compared across cities. Patterns were first analyzed from site to city; subsequently, common patterns were identified among projects. Categories generally follow the established interview protocol: perceptions and definitions of green infrastructure; relationship of green infrastructure and physical activity; public health considerations; power and collaboration; and measurement. Project level analysis teases out site issues of connectivity, challenges associated with multi-phased development, and green infrastructure maintenance considerations. Figure 3.3 portrays the sequence of the process.

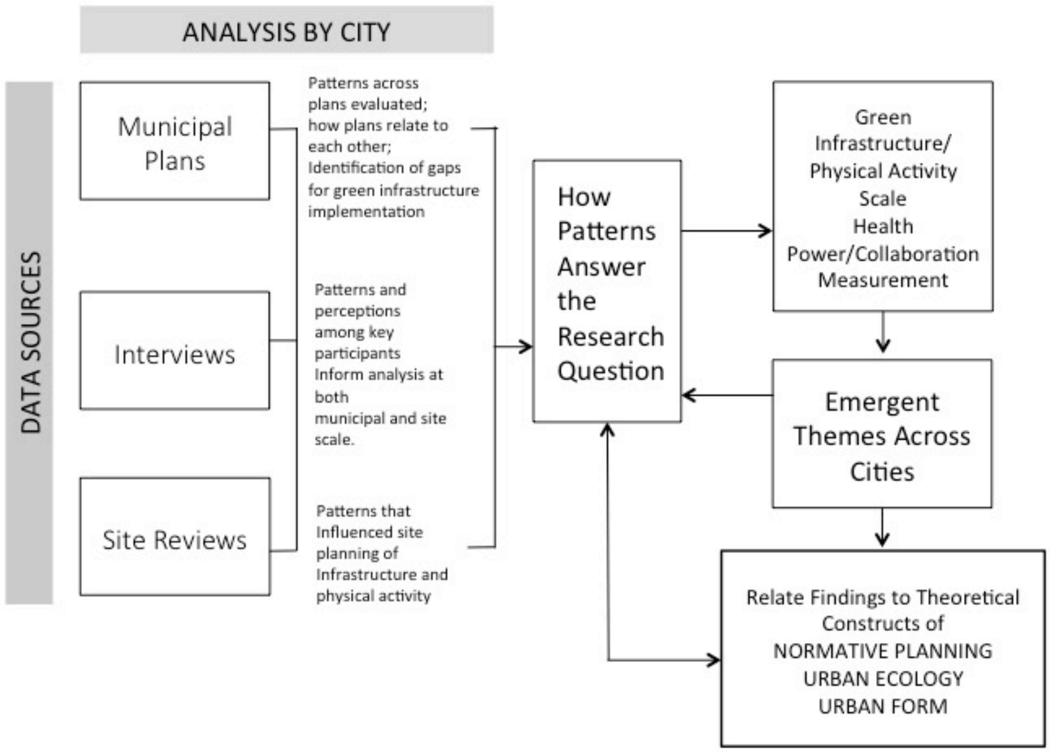

Figure 3.3 Methods: sequence of analysis

3.6 Issues of Validity and Replication

The structure of my case study design may be applied to other studies in terms of theory testing and development. Rich, thick descriptions have been employed to test emergent patterns through the analysis of interviews and published data. Fieldwork was conducted upon selection of cities and respective signature projects to assess site conditions and connectivity within the municipal context. Upon completion of interviews and analysis of municipal and project documents, on-site follow up analysis was conducted at each signature project to verify conditions and clarify potential discrepancies in data sources. Member checks were used to enhance internal validity with interview respondents by soliciting review of transcript information, and in some cases, site visits were conducted with interview respondents associated with the signature projects.

3.7 Limitations

My research is limited by the time frame of the study and its projects. One of challenges of post occupancy project evaluation is determining the 'best' time to examine the project. ULI conducts a case study one or two years after a project is completed, some projects are assessed after ten or more years (Francis 2001). Case studies are not generally effective on new projects, as it may be difficult to ascertain patterns of use and impacts resulting from design decisions made. Conversely, if a project is evaluated many years after construction, key participants may have moved on, and archival project records may no longer be available or difficult to obtain. Projects consisting of multiple phases have a long maturation process until build out is accomplished; this often results in multiple sets of plans and plan revisions. Another limitation was proximity to case study locations. As my pilot studies were conducted in Austin, and I worked as a liaison to the city on student research projects, my opportunities to obtain access to information may have been greater there than in other cities.

3.8 Summary

The theoretical outline employed in my study synthesizes perspectives from three distinct areas: normative planning; urban ecology; and good city form. My research design utilizes a collective case study approach to explore how green infrastructure as system may contribute to an urban framework that promotes a culture of health through affordances for physical activity. By evaluating municipal plans and signature projects in Austin, Denver, Louisville, and Portland, emergent patterns are identified in each city relative to the opportunities and challenges in implementing strategies toward a culture of health that encompasses human well being as a component of a healthy urban ecosystem. Patterns across cities are compared and contrasted to detect patterns both in support and opposition to health promotion.

To more fully understand the analysis and findings of the study, Chapter Four provides context of the four subject cities relative to answering the research question. This includes: a description of each city in terms of its municipal planning; enabling state legislation for planning; the municipal plans analyzed; and the setting of the signature project within each city.

Chapter Four: Four Green Active Cities

My research design is structured to compare and contrast the opportunities and challenges of green infrastructure to promote human physical activity. The design utilizes a signature project in each of four cities to tease out the opportunities and challenges at the municipal level toward building a multi-functional green infrastructure network. This network relates ecological processes and public space. As discussed in Chapter Two, components of green infrastructure are realized at multiple spatial scales in both institutional and ecological settings, posing challenges to urban ecological planning and design. In his discussion of incorporating nature in the city, Timothy Beatley argues that the best "green cities" are those where the scales intersect and overlap, working to deliver a nested system that exceeds the "sum of its parts" (Beatley 2011, 152). The successful overlap of site and city relates the context in which these scales and functions must interface in both policy and practice.

This chapter offers a description of each city to foreground study findings of emerging patterns and themes reported in Chapters Five through Eight. In providing the context for each case study city and plans evaluated, I aim to bring a rich understanding of issues explored in response to my central research question: how can a green infrastructure serve as a bridge between planning and public health to realize infrastructure that provides opportunities for human physical activity at the municipal scale? Discussion begins with an overview of planning and design in the regulatory process, followed by the role of the comprehensive plan and its position in city planning. Organized by subject city-Austin, Texas; Denver, Colorado; Louisville, Kentucky; and Portland, Oregon (Figure 4.1), each section includes: an overview of the city; enabling state legislation for planning; a brief chronology of planning in the city; summary of the plans analyzed; and portrayal of the signature project as it is situated within each city.

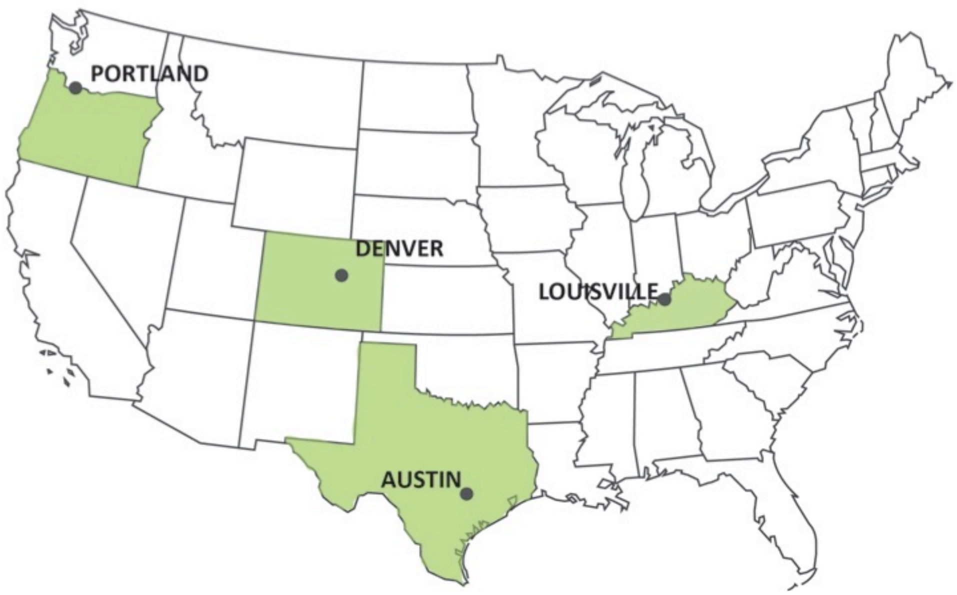

Figure 4.1. Locations of Case Study Cities in the U.S.

Finally, a summary provides a segue to the identification of emerging patterns in my analysis presented in Chapters Five through Eight.

4.1 GENERAL FRAMEWORKS FOR PLANNING AND DESIGN

My approach envisions the planner's role as a catalyst within a normative framework, a flexible structure that allows pushing the envelope in developing new strategies for urban design and planning. In this situation the planner provides information and creative resources, determining skills and knowledge required to solve problems and what alternative courses of action are available to the constituency being served (McHarg 2006, 88). Participants may then determine the physical design choices that best fit their values.

Critical to this viewpoint, the relationship of planning and design serves an important role in how green infrastructure is both conceptualized and operationalized to bring projects to fruition, as well as contribute to a larger system. Barriers encountered in projects to employ innovation may exist at various junctures in the regulatory process, including but not limited to: building permits, permit requirements for stormwater management site plan approvals, zoning amendments, compliance with comprehensive plan land use designations and policies, and other regulatory mandates by state and federal agencies. Figure 4.2 illustrates the process in a regulatory context.

The purpose of the regulatory process diagram intends to assist the reader in two ways: as a tool to situate the experiences of key participants relative to project and municipal processes; and to provide reference to outline junctures in the process. As Healey concedes in her discussion of governance processes (2003), such diagrams may help to capture the relationship between process and governance context. Multiple stages of interaction and decision making in the evolution from concept to project completion present opportunities and challenges at critical moments. Representation of what is built reflects authority and power (Hamin 2006, 148), impacting the narrative of the project. Regulatory requirements often influence project outcomes. Such requirements are in part, enabled by the comprehensive plan. The following section addresses the role of comprehensive planning within a normative planning framework, and its potential impact on realizing green infrastructure.

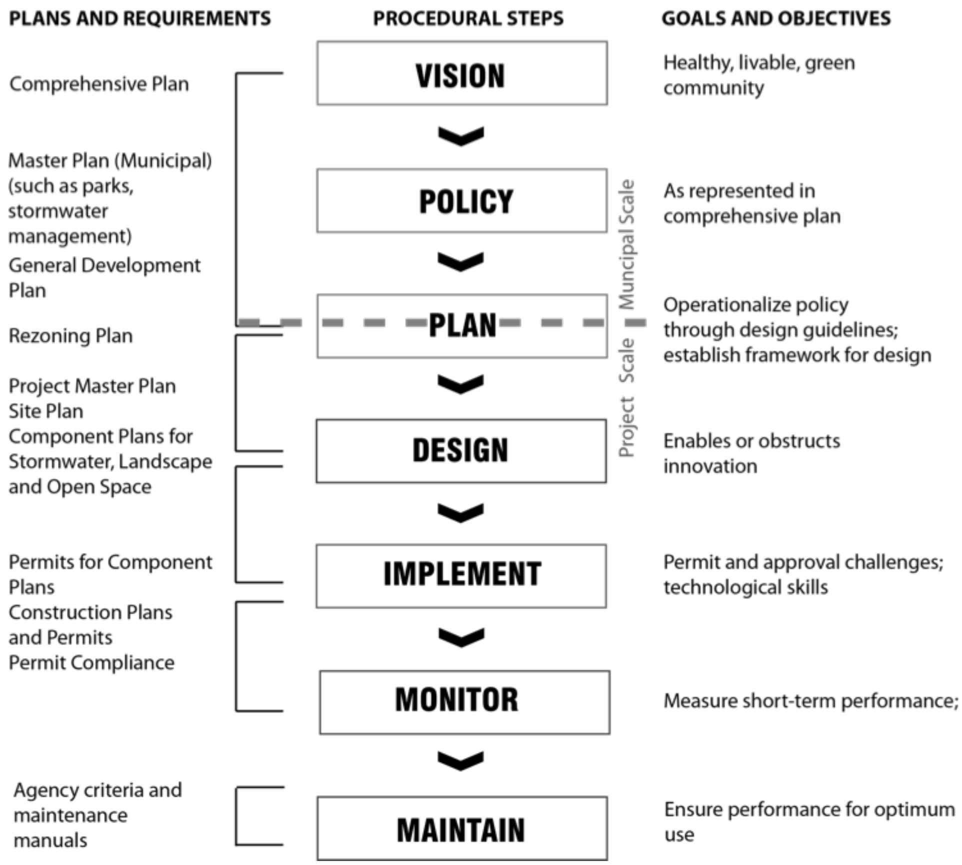

Figure 4.2 Project Regulatory Process

4.2 Rational Planning and the Comprehensive Plan

A comprehensive plan provides a conceptual planning framework to guide decisions relevant to human settlement patterns (Berke et al. 2006). Policies for transportation, land use, infrastructure, recreation, and conservation are typically included in the plan. Plans have been developed at city, county, regional, and state levels. For the purpose of this study, however, the comprehensive plan focuses on documents and accompanying exhibits prepared for political jurisdictions at the municipal scale.

In the United States, the role of the comprehensive plan in the land use regulatory process varies by state (Sullivan and Michel 2003). Historically, the Standard Zoning Enabling Act of 1926 (SZEA) served as model legislation that enabled local governments to address comprehensive land use regulation. Published shortly thereafter, the Standard Planning Enabling Act of 1928 (SPEA) was enacted as a companion piece to SZEA, situating the comprehensive plan as an integral element to city planning (Sullivan and Michel 2003). Written and distributed by the U.S. Department of Commerce, the model acts provided the basic institutional structure for planning and zoning.[22] Despite the fact city planning commissions were required to prepare and adopt a 'master plan' for future growth and development as a part of the act, individual plan components were not specified (Bunnell and Jepson 2011), leaving structure and contents to be determined by state and local governments.

The influence of the comprehensive plan on local planning and design can be attributed, in part, to its enabling state legislation. In some states, such as Delaware, Oregon, Florida, and Washington, the comprehensive plan is a legal standard for review of land use decisions (Sullivan and Michel 2003, 86), with prescriptive requirements delineating components included in the plan, and how often it must be reviewed and updated. In Oregon, Senate Bill 100 mandates local plans to align with state planning goals and guidelines (Knaap 1994). At the other end of the gamut are states such as Texas, who did not adopt the comprehensive planning element of SPEA until 1997 when state legislation enabled cities to adopt comprehensive plans (Texas Local Government

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[22] www.planning.org/growingsmart/enablingacts.

code, 211.004, 213). Across the spectrum, the enabling legislation significantly influences what elements are included in the plan.

Although there are differences among jurisdictions, most comprehensive plans generally contain: geographic coverage consistent with the political unit charged with decision-making powers, such as a city or town; long range planning perspective with a time frame of two decades or more; community vision describing the 'big picture' goals for the future, acknowledging economic and demographic projections within the designated planning horizon; policy focus that includes the basis for land use and other regulations; and integrated systems within a jurisdiction, such as environmental, social, physical, and economic (Godschalk and Anderson 2012, 36). The plan contains these system components in one public document, with a broad range of interpretations on levels of system integration among local government entities. Traditional planning models organize the plan into discrete elements for each component of the document, such as transportation, environment, utilities, transportation, parks and recreation, housing, and land use. In response to the isolated approach to separate elements of the plan, some cities have recently taken a more integrated approach to the comprehensive plan (Godschalk and Anderson 2012, 42). This approach addresses the interrelationship of elements as 'building blocks' linking plans to actions to achieve more sustainable solutions to growth and development (42).

The comprehensive plan often references functional master plans for individual plan elements or master plans prepared by municipal departments to further guide planning, design, finance, and operations. The intent of such plans provides a refinement and focus specific to a particular department or agency, such as parks and recreation, that is consistent with local, regional, and state comprehensive plans and policies frameworks (Godschalk and Anderson 2012, 55). Master plans vary among jurisdictions in terms of what types of plans are prepared and how the plan is vertically integrated or linked to the comprehensive plan and other city, regional, or state plans. As Katherine Gregor described in her account of planning history in Austin (2010), the comprehensive plan update appended a long list of policies, initiatives, and ordinances adopted over time, "prompting one to consider how to best connect the dots, now, on all these disconnected plans." As many functional plans are adopted independent of the comprehensive plan, discerning the relationship and impact of such plans on the regulatory flow of project approval can be difficult and time consuming.

For the purposes of this study, master plans evaluated include: parks and recreation, watershed protection, green printing/green infrastructure, and stormwater management. Since types and formats of functional master plans vary in each city, plans were selected that most closely align to answer the research question. The association between municipal plans and signature projects and subsequent evaluation may be influenced by the structure of planning and regulatory framework within each city. The following paragraphs describe the cities and respective plans evaluated.

4.3 Austin, Texas

Located in Central Texas along the Balcones Escarpment and the Colorado River, Austin is the state capital and seat of Travis County. It lies approximately 150 miles (241 kilometers) north of Houston, 160 miles (257 kilometers) south of Dallas, and 75 miles (120 kilometers) north of San Antonio. The Austin-Round Rock Metropolitan Statistical Area (MSA), as defined by the U.S. Office of Management and Budget,[23] reports a 2010 population of 1,716,000 persons. Austin is the eleventh most populous

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[23] http://www.census.gov/compendia/statab/2012/tables/

city in the United States, with 790, 390 reported in the 2010 census, occupying a land area of 297 square miles (76,922 hectares).[24] The city has been recognized for its green efforts in conservation, watershed protection, and green building construction. EPA named Austin one of ten model cities for green infrastructure in 2011. *Imagine Austin* (2012), the city's comprehensive plan, received a national award for sustainability in planning excellence from the American Planning Association in 2014.[25]

Austin has an international reputation as a leader in stormwater management based on its comprehensive monitoring activities, establishment and early adoption of BMPs for new urban development, and retrofitting of existing developments with new water quality controls (Karvonen 2011, 65). Its relationship between water resources and multifunctional greenspaces was clearly demonstrated by the bicentennial project in 1976, a comprehensive plan proposal which featured Shoal Creek and Waller Creek as organizing elements for both recreation and transportation infrastructure (Karvonen 2011, 66). Although the plan was not fully realized, the greenways and trails constructed near Shoal Creek remain a testament to recognizing natural environmental patterns and the important relationship of humans, water, and recreation.

4.3.1 Enabling Texas Legislation for Planning

When Texas adopted the SPEA in 1997, it enabled municipalities to prepare and adopt comprehensive plans (Sullivan and Michel 2003). Chapter 213 of the Texas Local Government Code (1997) states that the plan may include, but is not limited to "provisions on land use, transportation, and public facilities." The law also allows a

[24] www.factfinder.census.gov
[25] https://www.planning.org/divisions/sustainable/awards/

municipality to define the relationship between the comprehensive plan and development regulations. There are no other state mandates for comprehensive planning in Texas.

4.3.2 Planning in Austin

Austin engaged in city planning long before Texas adopted the SPEA. First chartered as a city in the independent Republic of Texas in 1839, the original plan commenced that same year when surveyors, under the direction of then future mayor Edwin Waller, laid out a grid comprised of fourteen city blocks. The city of 640 acres (259 hectares) fronted the Colorado River between Waller and Shoal Creeks, with the capitol forming the northern terminus of the city (Humphrey 2010). Over time, city growth and the nationwide city beautification movement motivated Austin leaders to engage in the first formalized planning process since its founding (Moore 2007, 32). *The 1928 Plan for Austin* (Koch and Fowler 1928) recommended better streets and sidewalks, provisions toward meeting the need for water and electricity, and a plan for budget allocations to meet such needs (Gregor 2010). Moreover, the plan, as former council member Sheryl Cole indicated, illustrated the power of the plan to racially separate the city. Recommending the designation of east Austin as “a Negro district,” the plan bifurcated the city at East Avenue (Humphrey 2010), which later became Interstate 35. This resulted in lasting spatial implications for the city’s growth and development (Moore 2007, 34). According to the city of Austin website, several resolutions for planning were passed by city council in the 1950s and 1960s.

Austin established its Planning Commission in 1973. City leaders developed a two-fold approach to growth management in the 1970s to: 1) guide location of future growth, and 2) protect environmental quality (Butler and Myers 1984). The *Austin Tomorrow* Comprehensive Plan was adopted in 1980, advocating stringent regulations for watershed protection in the western part of the city. To further support environmental protection of sensitive areas, policies for growth were channeled into a north-south corridor along the Interstate 35 freeway (City of Austin 1980). An interim update to *Austin Tomorrow* was completed in 2008.

4.3.3 Austin Plans Evaluated

Plan evaluation in Austin consisted of four documents: the comprehensive plan and master plans for parks and recreation, greenprinting, and watershed protection. *Imagine Austin*, the city's comprehensive plan, was adopted in 2012, with annual report updates issued to assess alignment with stated goals, and document tasks and projects accomplished. In addition to state legislation that enables planning, the city charter (amended 1985) Article X. Planning Section 5 sets forth local mandates. It states, "The Comprehensive Plan shall contain the council's policies for growth, development, and beautification of the land within corporate limits." Breaking away from traditional silo based elements, the plan is organized by interdisciplinary 'building blocks.' As one of eight priority programs, green infrastructure advocates protection of environmentally sensitive areas and integration of nature in the city. Subsequent to the approval of *Imagine Austin* the city initiated CodeNEXT, a multi-year project to revise the current Land Development Code by 2017.

City of Austin Watershed Protection Master Plan (2001) outlines strategies to reduce impacts of flooding, erosion, and water pollution on community to protect the environment, lives, and property. Goals include improvement of: waterways and aquifers for citizen use and support of aquatic life, and urban environment by supporting 'additional beneficial uses' of waterways and drainage facilities.

Austin Parks and Recreation Long-Range Plan for Land, Facilities, and Programs (2011) delineates goals for land acquisition, facilities, and programs for its parks system. It identifies gaps in services, intending to leverage support for general obligation bonds for future improvements.

The *Travis County Greenprint for Growth* was prepared in 2006 by the Trust for Public Land with a group of project partners that included the City of Austin, Travis County, The University of Texas at Austin School of Architecture, and multiple project stakeholders. Purpose of the greenprint was to inventory and identify resources to leverage existing available resources for establishing a better parks, recreation, and natural area system in the region. The greenprint is referenced in the *Imagine Austin* short-term (1-3 years) program for creating an integrated and ongoing green infrastructure plan (*Imagine Austin* 2012, 195). The municipal plans inform the goals for green infrastructure in Austin that will be included in the revised Land Development Code through the CodeNext process.

4.3.4 Mueller Austin, Compact and Connected

Mueller Austin is a 711-acre (288 hectares) mixed use development located approximately three miles (4.8 kilometers) north of downtown Austin, and two miles (3.2 kilometers) from The University of Texas at Austin. Home of the former Robert Mueller Municipal Airport, the site served as the primary facility for Austin's aviation travel from 1936-1999. The airport officially closed in 1999, moving its operations to the new Austin Bergstrom Airport, and the city formed a public private partnership with the

Catellus Group as Master Developer for the Mueller site. According to the project website,[26] no existing land uses were retained and the site remained vacant until 2007. After a two year process involving several plan iterations and many public meetings, the Master Plan Development Agreement and zoning to implement the Master Plan was approved in 2004. The Mueller Design Book, which sets forth guidelines for building design and construction, as well as public and private open space, was also issued in 2004 as a supplement to the Master Plan Agreement and the zoning provisions of the Planned Unit Development.

The plan approval process was extensive and cumbersome. According to one city official, 118 code requirements were violated by the proposed plan largely in areas of transportation and stormwater management issues (Hefner 2013). In 2007, construction commenced on the residential component of the development and the first commercial enterprises opened for business. The initial phase of parks and accompanying stormwater management system to support early phases of development opened in the summer of 2008.

The planned unit development includes a mix of residential, retail, and office uses. Mueller was designated as a Stage Two Leadership in Energy and Environmental Design (LEED) Certified Plan from the United States Green Building Council (USGBC) in its LEED for Neighborhood Pilot program.[27] It is the first development of its kind to be awarded this status (Catellus 2014, 5). Transit oriented development, with stations located within a 10 minute walk from all areas within the development was an integral part of the original development program. The ROMA (now McCann Adams in Austin) plan is presented in Figure 4.3.

[26] www.muelleraustin.com

[27] http://www.usgbc.org/Docs/Archive/General/Docs5205.pdf

Figure 4.3 Mueller Austin Illustrative Master Plan (source: www.muelleraustin.com)

The development program for Mueller Austin identified 10,000 residents, 10,000 jobs, 1,000 affordable housing units distributed throughout the development, and 140 acres (57 hectares) of parks and open space. The only structures preserved from the former aviation activities included a bow trussed hangar and the control tower, and minor areas of trees were preserved and /or relocated on site (Austin 2013). The project is approximately 40 percent complete as of April 2015, including approximately 140 acres (57 hectares) of parks and open space. The open space at Mueller serves not only the residents of the development, but is 100 percent open and accessible to the public. In this way, the plan worked to serve a broader area beyond its project boundaries, by addressing an existing parks and open space deficiency in the vicinity. The city and Catellus share ownership of the open space system.

4.4 Denver, Colorado

Denver is the capital and largest city in Colorado, situated in the center of the Front Range Urban Corridor, between the Rocky Mountains to the west and the high plains to the east. Denver reported a population of 600,158 persons in the 2010 Census. The city is comprised of a total land area of 154.63 square miles (39,885 hectares), with 1.63 square miles (420 hectares) of the total in water area. The Denver-Aurora-Broomfield MSA population was 2,543,000 in 2010.

Denver's commitment to urban form is reflected in its passage of a city charter for urban beautification, based on Daniel Burnham's 1893 World's Columbian Exposition at the Chicago Fairgrounds (Murray 2002, 283). Former mayor Robert Speer advocated the City Beautiful movement through several projects built during his tenure as mayor in the early 1900s, including Cherry Creek and Civic Center Park.[28] Larger

[28] http://www.denvergov.org/mayor/MayorsOffice/

parks included lakes for water storage, as well as cultural amenities.[29] Denver was recognized by EPA as one of its Green Infrastructure Community Partners in 2011.

4.4.1 Enabling Colorado Legislation for Planning

Structured as a city/county government, Denver is a distinct entity under Article XX of the state constitution that operates under a home rule charter and exercises the power similar to home rule municipalities to regulate local and municipal matters (Colorado Council of Government 2013, 27). The State of Colorado (Colorado Revised Statutes 30-28-106 and 31-23-206) has delegated most of the authority for land use planning to local governments. This legislation portrays an enabling, rather than a mandatory role, which impacts how policies are written and applied (Murray 2002, 286).

Local comprehensive plan mandates by the state include elements for recreation and tourism, and a master plan to guide future growth.

4.4.2 Planning in Denver

Founded in 1858, Denver grew from a group of mining camps settled on the banks at the confluence of Cherry Creek and the South Platte River to a regional center by 1890 (City and County of Denver 2000, 18). The "Park and Boulevard System" plan created by Edward Rollandet (1894), significantly influenced city planning in Denver. Its framework connected cultural destinations such as libraries and schools with parks via tree lined parkways and boulevards.[30] The concept for parks and parkways was further advanced in plans prepared by Charles Mulford Robinson in 1906, and landscape

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[29]http://tclf.org/sites/default/files/microsites/wot-guide-denver/legacy.html
[30]http://tclf.org/sites/default/files/microsites/wot-guide-denver/legacy.html

architect George E. Kessler in 1907. Developed over twenty years, the 'windmill' plans incorporated water resources within the city grid system.[31] The significance of these plans in shaping Denver city planning was recognized by the American Planning Association with a National Landmark Planning Award in 2003 as one of the first twentieth century urban parks plans.[32] As described in The Kessler Society's summary of works, urban form and use of water resources were celebrated in the Denver plan; however, the 'green grid' created an ornamental landscape vernacular in the city contrary to its arid mountain climate, requiring large volumes of water and often resulting in unsound maintenance practices.[33] The tree-lined parkways became icons of urban design in Denver (Etter 2007), setting precedents for many projects, including infill developments such as Lowry and Stapleton, a 4,700-acre (1,902 hectares) new urbanist community nine blocks north of Lowry on the former municipal airport property.

While Denver's parks legacy establishes green infrastructure in terms of conservation and open space, the importance of working landscapes is represented by its development of stormwater management strategies. Denver's Urban Drainage and Flood Control District is a national leader in development of software and techniques for hydrologic modeling, as applied to green infrastructure solutions such as biofiltration and green roofs (EPA 2011).

Another influential document guiding city planning in Denver was the *Downtown Area Plan*, which served as a prototype for *The 1989 Denver Comprehensive Plan* (City of Denver 2000). The plan proposed a vision to unify the city: "A city that is

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[31] https://www.planning.org/awards/landmarks.htm
[32] https://www.planning.org/awards/landmarks.htm
[33] http://www.georgekessler.org/

livable for all of its people" (City of Denver 2000). The 1989 plan centered on economic revitalization. The plan was superseded by *Denver Comprehensive Plan 2000*, which seeks to "manage growth and change through effective land use policies to sustain Denver's high quality of life" (1). Denver's comprehensive plan integrates regional scale plans and small area plans in its planning efforts. Figure 4.4 represents the relationships depicted in the plan.

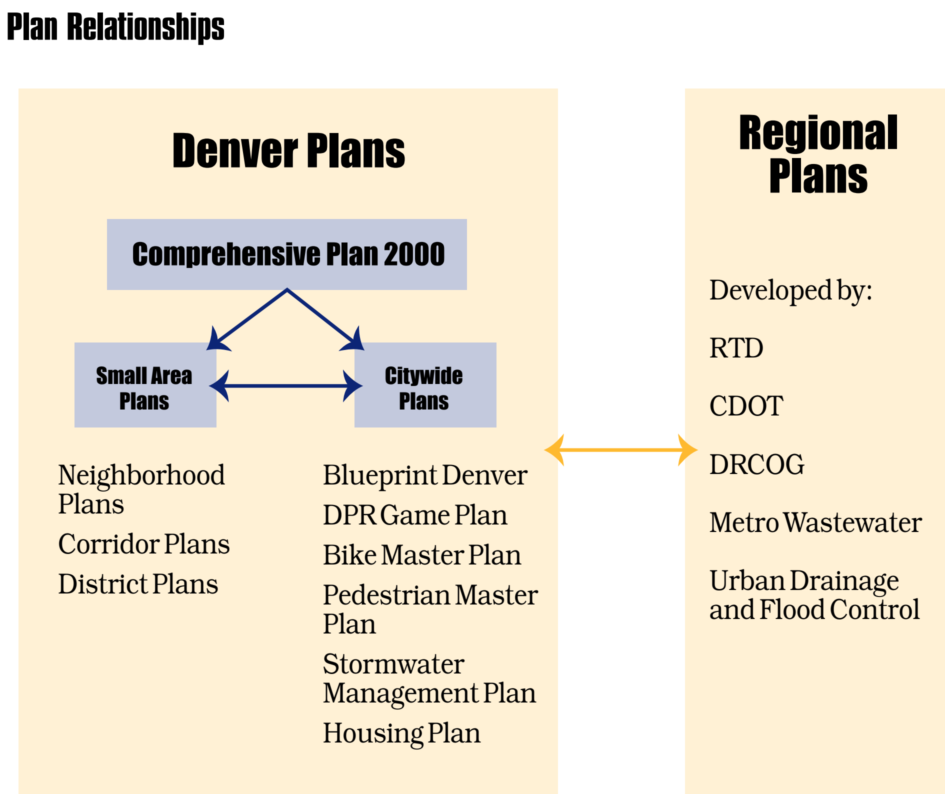

Figure 4.4 Plan Relationships in Denver (source: *Blueprint Denver*, 6)

Comprehensive Plan 2000 along with Citywide Plans such as the *Stormwater Management Plan* and the Department of Parks and Recreation's *The Game Plan* provide guidance to small area plans: neighborhood plans, corridor plans and district plans. Large-scale developments such as Lowry and Stapleton are represented in District Plans. The city of Denver plan states its intentions to collaborate with regional plan such as those by Colorado Department of Transportation (CDOT) and the Denver Council of Regional Governments (DRGCOG). In his evaluation of sustainable development and livable communities, Godschalk (2004) found Denver had shown to be effective in its green strategies at the city and small area plans scales, yet coordination of transportation planning and land use at the regional level remained relatively weak.

4.4.3 Denver Plans Evaluated

The four plans evaluated in Denver form a coordinated set of plans, centered on the comprehensive plan. The other plans address the areas of parks and recreation, water quality management, and greenprinting. *Denver Comprehensive Plan 2000* is organized around four core principles: economic opportunity, environmental stewardship of natural resources, equity in opportunity for a high quality of life, and engagement to build collaborative partnerships. In an effort to more closely align its outdated land development regulations with current city policy goals and objectives, *Blueprint 2000* (2002) was produced as a companion document to the comprehensive plan. It identified areas of stability for protection and areas of change for development to guide sustainable growth (Godschalk 2004). Functional master plans by various city departments were also prepared as adjunct documents to the comprehensive plan.

The Game Plan (2003) prepared by Denver Parks and Recreation engaged numerous agencies, consultants, and multiple stakeholders in its collaborative plan. The program outlines a long range vision of city in park built upon five broad themes:

building new parks in new places; celebrating the Colorado landscape in the city; responding to twenty-first century needs and trends; transforming open space into green infrastructure; and connecting the public realm.

In preparation of its *Water Quality Management Plan* (2004), city staff members reviewed national case studies in Portland, Austin, and three other cities. The plan contains four goals: framework and shared vision for meeting Denver's stormwater quality requirements and goals; BMP strategies that work in various Denver settings; common foundation for interdepartmental understanding of stormwater quality requirements and role in the planning process; and a framework for future needs to meet stated goals. Its chapter on best management practices was subsequently published as a separate document to provide guidance for communities throughout the Denver region.

Greenprint Denver was adopted by the city council in July 2006. The purpose of the greenprint intends to support and further integrate sustainable practice into Denver's policies and programs, convene stakeholder groups, catalyze innovation, and communicate sustainable development as a core value to Denver.

The plans evaluated in Denver at the municipal scale form an effective transition to the project scale, identifying the redevelopment of Lowry as an area of change within the city.

4.4.4 Lowry Denver, Infill Integrating History

Located approximately eight miles (12.9 kilometers) directly east of downtown Denver, the Lowry redevelopment project is comprised of 1890 acres (765 hectares), with 40 percent devoted to open space. A mixed-use community, it is comprised of mid-twentieth century housing renovated and/or preserved, and neo-traditional redevelopment. Population at Lowry has nearly tripled since 2000 (Piatkowski and Marshall 2014, 231). The development is located on the former site of Lowry Air Force Base, "one of the nation's most important technical training centers" in operation from 1934–1994 (Ballard et al. 2013, 8). Lowry was developed based on an interlocal agreement between the City of Denver and City of Aurora, establishing the Lowry Redevelopment Authority (LRA). Approximately 89 percent of the project is within the city of Denver, while the remaining eleven percent lies within the city of Aurora. The project master plan is illustrated in Figure 4.5.

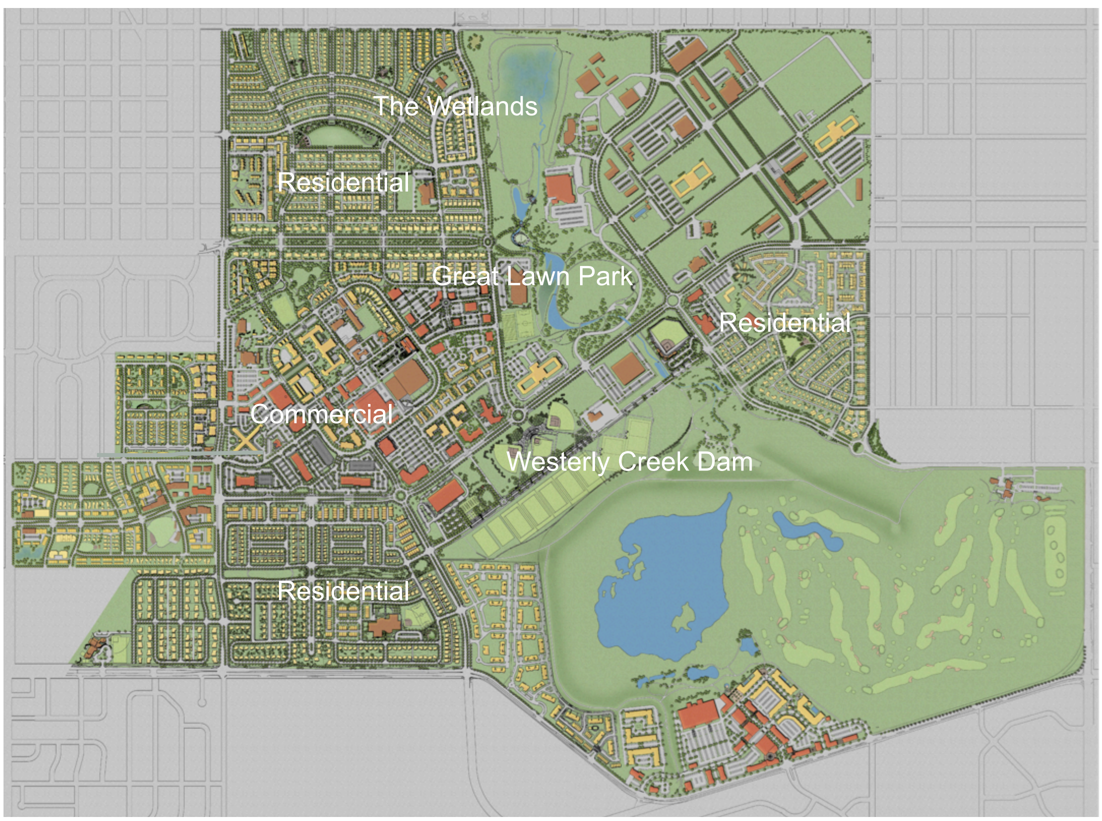

Figure 4.5 Lowry Denver Illustrative Master Plan (source: Design Workshop, Denver)

Based on information obtained from the LRA, the original development program envisioned 4,500 homes, 130,000 square feet (12, 077 square meters) of retail space, 1.8 million square feet of office space (167,226 square meters), and 800 acres (323.7 hectares) of parks and open space. Several existing building were preserved or modified to accommodate new uses, significantly affecting the spatial configuration of the design (Stern 2006). A particular challenge confronted by the LRA existed with the public benefit conveyances (PBC) that made selected uses available to certain public uses such as education, health care, and recreation. The priorities evolving around the PBCs greatly influenced development of the master plan. According to LRA director Monty Force, "PBC's can make 'Swiss cheese' of a project" (Stern 2006). After conveyance of PBC parcels, LRA was faced with developing the master plan around the remaining parcels of land.

According to the timeline provided on the Lowry website,[34] the Lowry Community Reuse Plan submitted to the Air Force in 1994 delineated major use areas for the redevelopment. It was adopted by the city councils of Denver and Aurora in 1995. The first commercial tenant renovated the former base commissary in 1995. Zoning was approved by the city of Denver in 1996, and new home construction commenced in 1997. The first residents moved into new homes in April 1998. Development of commercial, residential, and educational facilities continued, with over 25,000 people living, working, or going to school in Lowry by 2006. The development plan for the last remaining parcel not under agreement was approved in 2012.

Organized around Westerly Creek with a vision of preserving the art, culture, and history of the former military installation, spatial configuration of the site relied on

[34] http://www.lowrydenver.com/art-and-history/history-of-redevelopment/

transforming a section of the creek from a closed conduit to an integral component of a multi-functional green infrastructure system. The City of Denver and the Lowry Master Community Association share maintenance responsibilities for the public open spaces within the development.

4.5 Louisville, Kentucky

Louisville, a city with a population of 597,337 as reported in the 2010 census, occupies a total land area of 399 square miles (103,341 hectares), with 13.0 square miles (3,367 hectares) of water area. Its metropolitan area (MSA) includes a small portion of southern Indiana, reporting a 2010 population of 1,284,000. The city's origin dates back to the late eighteenth century, when it was settled on the southeasterly border between Kentucky and Indiana on the Ohio River in north-central Kentucky. Louisville is Kentucky's largest city and the seat of Jefferson County government. In 2003, the city and county governments merged to form the Metro Louisville Government.[35]

4.5.1 Enabling Kentucky Legislation for Planning

Kentucky Revised Statutes (KRS), Chapter 100 authorizes "the creation of a planning commission with various responsibilities and authorities, the most fundamental of which is the drafting of a comprehensive plan" (KRS 100, 5). Legislative bodies can adopt land use regulations only after they have adopted a comprehensive plan, stating goals and objectives and plan elements. Furthermore, such regulations must aid in furtherance of the plan's goals and objectives. Required plan contents include: a statement of goals and objectives, a land use plan element, a transportation element, a

[35] https://louisvilleky.gov/

community facilities plan element, and any additional elements deemed necessary by the judgment of the planning commission that further serves the purpose of the plan (KRS 100.187).

4.5.2 Planning in Louisville

The concept for connected green space in Louisville goes back to city founder General George Rogers Clark's vision for "a progression of built-up places and interspersed public greens" including "cross-town greenbelts" (Northern 2012, 43). Clark envisioned the riverfront as a town commons (Byck 2012). The parks and open space system was significantly influenced by landscape architect Frederick Law Olmsted, Sr. who first visited Louisville as secretary general of the U.S. Sanitary Commission in the 1860s, and participated in the layout of the Jeffersonville Quartermaster Depot between 1871-1874 (Kleber 2001, 675). He accepted the challenge of creating a systematic plan for Louisville's parks and parkways in 1891 (Bell 2011, 147). According to Liz Dehart of the Louisville Olmsted Conservancy, the city is home to one of five Olmsted Parks and Parkways systems in the United States.

Currently, comprehensive planning in Louisville is represented in *Cornerstone 2020,* the first comprehensive plan developed for Louisville and Jefferson County since the comprehensive plan adopted in 1979 (Baker et al. 2010, 8). Confronting post World War II sprawl and leapfrog developments, city leaders responded by developing guidelines for mixed-use form districts rather than single use zones following inefficient land use patterns (Bennett and Gatz 2008, 24). The seven-year process in preparation of the plan began in 1993. Goals generally align with statutory plan requirements, with added elements for marketplace and livability.

4.5.3 Louisville Plans Evaluated

The *Cornerstone 2020 Comprehensive Plan* was adopted in June 2000 as an update to the 1979 plan. The plan identifies four major strategies for its long term planning horizon: community form, mobility, marketplace, and livability. In preparation for the plan, study committees addressed current and future planning efforts for land use, parklands, open space, transportation, and economic growth. Adjunct documents to the comprehensive plan were prepared for parks and open space, water quality, the Ohio River Corridor, the Jefferson Memorial Forest, and other specific areas.[36] Plans were primarily developed through the work of key committees composed of citizens, business and government leaders, and staff. Consultants prepared documentation on specific areas such as parks and open space.

Parks and Open Space Master Plan was initially adopted in 1995 as an integral component of Cornerstone 2020 Comprehensive Plan. Four major goals were identified in the plan: well-maintained parks to meet residents needs; network of open space and green way corridors that protects natural resources; system that preserves and enhances visual quality, protects cultural resources, and provides opportunities for education; and open space network that acquired and manages land to 'protect public health and safety.'

Louisville's *Stormwater Management Master Plan* was adopted in August 2010. The intent of the plan promotes stormwater drainage practice as part of a regional program. Study area includes all of Jefferson County, taking a watershed approach to stormwater management.

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[36] www.louisvilleky.gov

The *Ohio River Master Plan* was prepared for the city of Louisville and the Jefferson County Planning Commission in 1996 ancillary to *Cornerstone 2020*. The plan documented a 25-year policy framework to guide development along the river corridor and connect people to the river, to each other, nature, work, and the past, present, and future. It addressed the importance of the 37-mile (59.5 kilometers) corridor along the river in the future of Louisville's growth and development. One of the components included a concept for an "Ohio River Corridor Trail" to attract people to the riverfront. Improvements to the city's waterfront play a significant role in Louisville planning, dating back to the 1931 Comprehensive City Plan prepared by Harland Bartholomew Associates (Bell 2011, 176). The plan was realized, in part, through the development of Waterfront Park.

4.5.4 Waterfront Park, Reclaiming Louisville's Riverscape

Developed in three phases over fifteen years, this 85-acre (34.4 hectares) park along the Ohio River sought to reclaim Louisville's downtown waterfront, a part of the original city plan that had not yet been realized. The Bartholomew plan proposed the Belvedere, although the three-block elevated promenade and public plaza near the Waterfront Park site was not completed until the early 1970s.[37] Subsequently, several studies were conducted for riverfront development. In 1981, the Louisville and Jefferson County planning commission prepared the "The Riverfront Plan," which criticized the lack of access to the riverfront for public purposes (Bell 2011). The plan also denounced past efforts for redevelopment claiming, "the Ohio riverfront is everyone's front yard but no one's responsibility" (Bell 2011, 231). The "Waterfront Redevelopment Strategy"

[37] www.louisvillewaterfront.com/events/venues/belvedere/

(1985) led to creation of a formal structure for redeveloping property largely occupied by unsightly industrial uses.

The Waterfront Development Corporation (WDC), an organization crafted through a "unique agreement between Jefferson County and the city of Louisville (now Louisville Metro government), local philanthropists, and the Commonwealth of Kentucky in 1986" (Bennett and Gatz 2008, 21) was charged with responsibility to reclaim the waterfront. Development in the vicinity of the project "The Louisville Waterfront District" is governed by a special zoning regulation referred to as the Waterfront Development Review Overlay District (WRO).[38] Its purpose lies in protecting and enhancing "the desired image of the district."[39] Projects within the district require WDC review and approval prior to applying for plan and permit approvals from Louisville Metro. The district is comprised of five categories: 1) A-1, Downtown CDB, intended for a high degree of use with parks and supportive residential and commercial uses; 2) A-2, which provides potential to expand the downtown waterfront oriented businesses and public use; 3) B, intended for a mixture of public and private uses; 4) C-1, to provide river-oriented industrial uses, without precluding access to the river's edge; and 5) C-2, south of River Road, anticipated for both private open space and recreational use on its eastern end. Accessibility to the park comprises a major component of the WRO District's character.

Programmed used for the park evolved from a series of public meetings. According to WDC Director David Karem, "Every place we could go and talk about it, we went. About 100 presentations a year for three years, anyone who wanted to hear us talk, we went there" (Bell 2011, 28). The city began acquiring industrial properties and

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[38] Metro Ordinance No 66-2004

[39] Metro Ordinance No 66-2004

clearing them in 1988. Figures 4.6 and 4.7 illustrate site conditions prior to acquisition, and after the completion of the park's first phase, respectively. The initial phase of the park, to the west and immediately adjacent to downtown opened in 1999, the second on the eastern end in 2004, and the third phase-the remaining center section-opened to the public in 2009 (See Figure 4.8). The second part of phase three was completed in 2013 with the opening of the Big Four Bridge, a former railroad bridge spanning the Ohio River. It now provides a pedestrian and bicycle connection from Waterfront Park in Louisville to Big Four Station in Jeffersonville, Indiana. The Louisville Loop, a 100-mile (161–kilometer) multi-use trail, originates at the base of the ramp to the Big Four Bridge. The Loop, approximately 40 percent complete as of April 2015, travels through five physiographic regions as it traverses the city.

Figure 4.6 Louisville's industrial urban riverfront development (source: www.louisville.gov)

Figure 4.7 Phase I of Louisville Waterfront Park (source: www.hargreaves.com)

Figure 4.8 Waterfront Park Master Plan (source: www.louisvillewaterfront.com)

A master plan report for Phase IV of Waterfront Park, comprised of twenty-two additional acres (8.9 hectares) west, but not directly adjacent to the existing park was completed in 2014 (MKSK 2014). It is envisioned as a continuation of the riverfront experience to provide a range of public open spaces.

4.6 PORTLAND, OREGON

The largest city in Oregon and the seat of Multnomah County, Portland lies in the northern portion of the Willamette Valley, near the convergence of the Willamette and Columbia Rivers. The city was incorporated in 1851, and from its inception the Willamette River served as a boundary between east and west Portland. In the 2010 census, Portland reported a population of 583,776, and a total land area of 145 square miles (37,555 hectares), with 12 square miles (3,109 hectares) of water area. The MSA population in 2010 was 2,226,000.

4.6.1 Enabling Oregon Legislation for Planning

Oregon's first land use ordinances were enacted in Portland in 1918.[40] According to the Oregon Department of Land Conservation and Development (LCDC), Oregon cities were permitted to zone private land in 1919, with counties given zoning authority in 1947. Comprehensive planning was initiated on a statewide basis in 1969 by Senate Bill 10, which required each city and county to prepare a plan in accordance with state standards. Lacking effective enforcement procedures or a program of technical assistance from the state, many counties and cities refused to develop comprehensive

[40] http://www.oregon.gov/lcd/pages/history.aspx

plans.[41] In response, the Oregon legislature passed Senate Bill 100 in 1973, with an improved program for land use planning based statewide program to be directed by the LCDC (LCDC 2010). The program is founded on nineteen planning goals. The goals describe state policies on issues such as land use, housing, and natural resources. Goals 15 through 19 address location specific areas. Goal 15 sets forth goals and requirements for the Willamette River Greenway (portions located in Portland), and Goals 16-19 deal directly with coastal issues such as Estuarine and Ocean Resources. Most of the goals are administered through local comprehensive plans, prepared by cities and counties (Abbott 2005), accompanied by a set of implementing measures such as zoning and land-division ordinances. These laws are not limited to city government, but also apply to state agencies, counties, and special districts.[42] Special districts may function within a single jurisdiction, or extend beyond city and county boundaries to provide services to address such items as fire protection, port authority, or rural irrigation (Abbott 2005). Special districts may also exist within a city for a substantial segment that covers multiple neighborhoods. The state land use planning legislation requires cities to create urban growth boundaries to guide development. Local governments are required to coordinate with special districts in planning efforts.

4.6.2 Planning in Portland

Portland has long enjoyed a reputation for its environmental and green space planning, referred to as the "greenest city in the United States" (Abbott 2011, 171). John Charles Olmsted, nephew and adopted son of Frederick Law Olmsted, Sr. travelled to Portland in 1903 to design the fairgrounds for the centennial of the Lewis and Clark

[41] http://www.oregon.gov/lcd/pages/history.aspx
[42] http://www.oregon.gov/lcd/pages/goals.aspx

Expedition, subsequently focusing his attention of Portland's park system.[43] He presented his proposal in the *Report of the Portland Park Board* (1903) a long-range citywide plan for a system of parks and open space. In its early attempts to set precedents for implementing green infrastructure, Portland former city council member Sam Adams challenged EPA and other federal agencies to align its policies with green initiatives, stating "existing policies and rules must be reviewed and updated to reflect the green revolution that is occurring in the environmental sciences and civil engineering" (House Committee on Science and Technology 2007, 2). Portland failed to gain state and federal support for green technologies from the Oregon Department of Environmental Quality (ODEQ) and EPA, as the agencies at that time favored traditional 'gray' engineering solutions (House Committee on Science and Technology 2007, 3). Since that time, Portland has instituted multiple and diverse green infrastructure projects throughout the city.

In addition to the local comprehensive plan, planning in the Portland metropolitan area is governed by Metro, a three county regional government entity that encompasses 25 municipalities and a number of unincorporated areas (Berg 2012). Council members are elected from six geographic districts, placing a strong focus on regional planning efforts.[44] In 1995, Metro adopted the *2040 Growth Concept,* a long-range plan that identified ten urban design components as focal points for growth. Metro has actively acquired open space through its parks and natural areas program, developed parks, and helps plan and develop trails in the region (McTighe 2013; Engstrom 2013).

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[43] http://www.oregonencyclopedia.org/articles/olmsted_portland_park_plan/

[44] www.oregonmetro.gov

4.6.3 Portland Plans Evaluated

Portland's *Comprehensive Plan 1980,* including amendments through November 2011, was designed to provide a coordinated set of guidelines for decision-making to guide future growth and development of the city. The plan includes: a comprehensive plan map and set of regulations for development; a guide for the major public investments required to implement the plan; and a process for review and amendment of the plan. Specific actions are linked to comply with statewide planning goals. The envisioned planning horizon is 20 years; the plan is to undergo major review every five years. The cycle, however, has been interrupted by several factors, including suspending the requirement due to budget concerns (Engstrom 2013). At the time of data collection, Portland was in the process of updating its comprehensive plan.

The 2005 Portland Watershed Management Plan and *5-Year Implementation Strategy 2012-2017* identify Portland's comprehensive approach to improving current watershed health. The plan presents watershed issues on a citywide scale as a system plan, much like other city agencies. Plan is consistent with and complements other city system planning work: Comprehensive Plan, the River Plan, Public Facilities Plan, and Transportation Plan,

Portland's Green Infrastructure: Quantifying the Health, Energy, and Community Livability Benefits was prepared for the city's Bureau of Environmental Services (BES) by environmental consultants in 2010. The primary purpose of report is to be used in BES Systems Planning and Alternative analysis for ranking projects, and become part of infrastructure decision-making. It intends to inform the Comprehensive Plan update, city council policy decision, and mayoral efforts to promote green infrastructure.

Planning for parks and recreation relies largely on three plans: the *Parks Vision 2020, 2009 Progress Report, and 2012-2015 Strategic Plan*. The original plan outlines five goals for a time frame of 20 years to: 1) ensure Portland park and recreation legacy for future generations; 2) provide a wide variety of recreation facilities and opportunities for all citizens; 3) preserve, protect, and restore Portland natural resources to provide nature in the city; 4) create an interconnected regional and local system of trails, paths, and walks, to make Portland the "walking city of the west;" and 5) develop parks, recreation facilities, and programs that promote community in the city.

The *2009 Progress Report* refined goals and developed a grading system for measuring progress, citing the original plan's lack of structure to assess whether or not it was meeting stated goals. The *Strategic Plan* set forth short-term goals and strategies for action in accordance with preceding plans.

As part of downtown revitalization efforts in the 1970s, parks planning in Portland focused on creating a downtown waterfront park, closing a six-lane freeway to invite public access to the river (Orloff 2004). Waterfront access was extended with transportation safety improvements to the collection of four downtown bridges that span the Willamette. Access serves both bicycle and pedestrian movement between east and west, previously separated by the river. Working toward a goal of a riverfront trail system and connecting segments of the Willamette Greenway, the Eastbank Esplanade provides a link to the system on downtown Portland's "the opposite shore."

4.6.4 Eastbank Esplanade–Between the River and the Freeway

The Vera Katz Eastbank Esplanade comprises one in a series of initiatives to provide pedestrian and bicycle access to and across the Willamette River. Beginning in the 1960s citizens protested a multi-lane widening of Harbor Drive, which eventually led to the closing of the road adjacent to the west bank of the river (DuRoche 2012). The city-county sponsored Downtown Plan (1972) envisioned a pedestrian oriented riverfront on the west bank of the Willamette, with a mixed-use downtown core (Abbott 2005). Completion of the Interstate 405 Freeway and the Fremont Bridge in the early 1970s served as a replacement for six-lane Harbor Drive. After abandoning the right of way for Harbor Drive in 1974, Tom McCall Waterfront Park was constructed in its place. The 36-acre (14.6 hectares) park was completed in 1978, and a master plan update was finalized as part of a river renaissance project in the early 2000s (EDAW n.d.). One of the major goals in the master plan update was to integrate the trails in the park with downtown pedestrian corridors and other regional trails. Eastbank Esplanade provides a critical link in the trail system.

The Eastbank Esplanade was included in the 1988 Central City Plan,[45] and Hargreaves Associates conceptualized the Eastbank Riverfront Park Master Plan in 1994.[46] The *Eastbank Riverfront Park Schematic Plan* was completed in 1998, with a project team led by Hargreaves, and including Mayer/Reed, a local landscape architecture firm. The schematic design book served as the guiding document for park development. Design objectives included: simple repetitive pattern that provides consistency and clarity; floating walkways to provide physical access to the river; urban markers to symbolically connect the park to the east side street grid; and riparian gallery to display native species appropriate to the river bank

The Eastbank Esplanade significantly improved access to and within the downtown trail network upon completion of its first phase in 2001. Situated between the

[45] http://www.portlandoregon.gov/parks/

Interstate 5 freeway and the eastern shore of the Willamette River, the project was funded in part by a federal Intermodal Surface Transportation Efficiency Act (ISTEA) grant.[47] The 1.5 mile (2.4 kilometers) linear park extends northward from the Hawthorne Bridge in downtown Portland to the Steel Bridge, providing views of the Tom McCall Waterfront Park and other downtown destinations on the west side of the river. The project was conceived as an urban renewal project to rebuild a bicycle bypass destroyed by flooding in 1996 (Orloff 2004, 158). The esplanade includes a 1,200-foot (370 meters) floating walkway. The park links to the Willamette Greenway, which is addressed in Goal 15 of the statewide planning goals.

Another driving force in development of Eastbank Esplanade emanated from the unsightly views of the east side of the Willamette from the Tom McCall Waterfront Park. Carol Mayer–Reed, landscape architect and project manager explained the derelict conditions of the proposed park site: “When you’re standing in Tom McCall Waterfront Park, you’re looking at an ugly freeway, it reminds you of that fact that you can’t get over there. And it was really unattractive. There were some of the worst crimes in the city going on over there, really bad stuff, because there was an old beat up asphalt trail that dead ended and nobody–only the unsavory folks of society–went over there.” There was a need to make a better connection to the east side of the river and provide access back provide connectivity through the development of the park.

Following acceptance of the schematic plan, Mayer/Reed led the design effort for the project, creating the linear corridor and its series of public spaces along the river. Figure 4.9 represents Mayer/Reed’s plans for the Esplanade.

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[47]www.portlandoregon.gov/cbo/artilce/18178

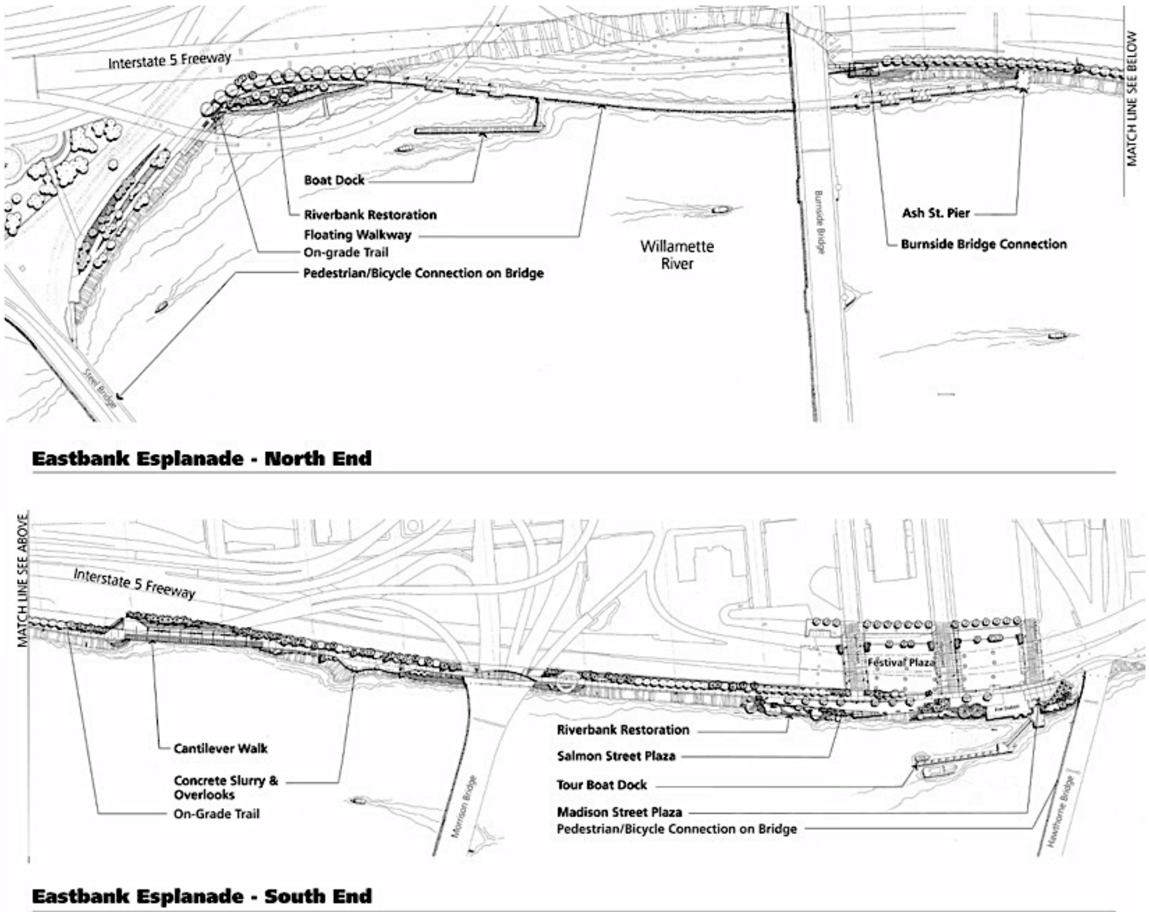

Figure 4.9 Eastbank Esplanade Illustrative Master Plan (source: Mayer/Reed, Portland)

Plazas are located at specific junctures; ground marking signs and public art installations provide orientation and wayfinding landmarks along the length of the trail. Among its many accolades, the park received a National Merit award from the American Society of Landscape Architects in 2004, with awards jurors commenting, "Portland does it again with a brilliant bike path…Elegant, strong forms with successful engagement of riverfront." [48] In addition to its bioengineered banks and boat docks, the

[48] http://www.asla.org/nonmembers/publicrelations/pressreleases/press04/pressrelease071304.htm

simple geometric design completes a continuous three-mile pedestrian loop downtown. The park was named for Vera Katz, former mayor of Portland in 2004.

4.7 The Dynamic Relationship Between Municipal Plans and Signature Projects

The relationship of municipal planning to its state enabling legislation influences the content, composition, and often the timing of comprehensive plans. During the design process, the goals and objectives of those plans, along with applicable codes direct design decisions as to how green infrastructure is conceptualized and operationalized. Exploring the origins and legislative influence of plans in subject cities provides a background to provide insight for strategies followed and decisions made in the planning and implementation at both the municipal and project levels. Building this context informs the relationship between the municipal plans and projects. A summary of the municipal plans reviewed is portrayed in Table 4.1. The four signature projects are summarized in Table 4.2.

Table 4.1 Summary of Case Study Cities and Municipal Plans Reviewed

	Austin	Denver	Louisville	Portland
City Population	790,390	600,158	597,337	583,776
Metropolitan Area Population	1,716,000	2,543,000	1,284,000	2,226,000
Total Area	297 sq. mi. (76,922 hectares)	154.6 sq. mi. (39,885 hectares)	399 sq. mi. (103,341 hectares)	145 sq. mi. (37,554 hectares)
Form of Government	Council-Manager Mayor and 10 council members from geographic districts (as of 2014)	Consolidated city/county; non-partisan elected mayor, auditor, and 13-member city council (11 districts, 2 at-large)	Consolidated city/county; resembles mayor-council form; mayor has executive powers; 26 member council from geographic districts	Commission; mayor, 4 commissioners and auditor are elected officials; members have legislative, administrative and quasi-judicial powers
PLANS EVALUATED				
Comprehensive Plan	Imagine Austin (2012) with annual report updates; eight priority programs, including one for green infrastructure	Denver Comprehensive Plan (2000) Supplements to the plan have been prepared by city departments and adopted by city council	Cornerstone 2020 (2000); fifteen guidelines with corresponding goals and objectives. Includes 11 Form Districts	Comprehensive Plan 1980, including amendments through November 2011; specific actions linked to comply with mandatory statewide planning goals
Parks and Recreation	Austin Parks and Recreation Long Range Plan for Land Facilities and Programs 2011-2016 (2011)	The Game Plan (2004) Long term vision for city parks	Parks and Open Space Master Plan (1995); framework for parks system for next 25 years	Parks Vision 2020, 2009 Progress Report, and 2012-2015 Strategic Plan; long-term vision with short-term strategies for action
Watershed Protection/Stormwater Management	Austin Watershed Protection Plan (2001)	Water Quality Management Plan (2004)	Stormwater Management Master Plan (2010)	Portland Watershed Protection Plan (2006), and 5 Year Implementation Strategy 2012-2017 (2012)
Greenprinting/Green Infrastructure	Travis County Greenprint for Growth (2006)	Greenprint Denver (2006)	Ohio River Master Plan (1996)	Portland's Green Infrastructure: Quantifying the Health, Energy, and Community Livability Benefits (2010)

Table 4.2 Summary of Signature Projects

	Austin	Denver	Louisville	Portland
Project	Mueller Austin	Lowry	Waterfront Park	Vera Katz Eastbank Esplanade
Project Type	Mixed Use Infill, Planned Unit Development	Mixed Use Infill, Planned Unit Development	Urban Park	Linear Park
Project Area	711 acres (288 hectares)	1890 acres (765 hectares)	85 acres (34.4 hectares)	1.5 miles (2.4 kilometers)
Organization Responsible for Development	Public/Private partnership	Development authority by interlocal agreement	Quasigovernmental Entity (Waterfront Development Corporation)	City of Portland Parks and Recreation Department
Year Opened	2006	1998	1999	2001
Percent Project Complete	40%	95%	100%	100%

The timing of municipal plans and projects may also affect the relationship between the scales, and reciprocal influence. Mueller Austin illustrates how project milestones intersect and overlap with municipal plan milestones. Table 4.3 illustrates the chronology of plans and project. In the dynamics of planning, timing of municipal plans and projects illustrate the complexity of issues as well as how one may influence the other at particular milestones. The complexity of timing in evaluation permeates analysis in each of the four case study cities.

Table 4.3 Timeline of Municipal and Project Milestones in Austin

Time in Years	Austin Municipal Plan Milestones	Mueller Project Milestones
1984		Citizens for Airport Relocation (CARE) release Mueller Redevelopment Plan
1997		City contracts planning consultant (ROMA*) to refine redevelopment plan
2000		City adopts ROMA redevelopment plan
2001	City adopts *Watershed Protection Plan,* in first attempt to develop and implement an integrated process for watershed protection	
2004		City adopts Master Development Agreement and PUD zoning development plan for Mueller
2006	Trust for Public Land in partnership with several entities, including the city of Austin, issues *Travis County Greenprint for Growth* as combined community vision for environmental & cultural resources	
2007		First commercial development opens at Mueller; construction begins on single-family homes
2008		First parks open at Mueller: Lake Park, Southwest Greenway, and Ella Wooten Park; construction begins on single-family homes
2009		First multi-family development opens at Mueller
2011	City adopts *Austin parks and Recreation Long Range Plan for Land, Facilities, and Programs 2011-2016,* a strategic plan to leverage funding; references Mueller parks as model for public-private partnership	
2012	City adopts *Imagine Austin* comprehensive plan; references Mueller compact and connected development throughout	
2013	City begins *CodeNEXT,* a 3-year process to update Land Development Code	

*ROMA became known in its Austin office as McCann/Adams Group, and remained on consultant team through multiple project phases.

4.8 SUMMARY

This study compares four signature projects; all reclaimed land and repurposed land uses in cities celebrated for green strategies in both municipal planning and implementation. In Austin, with scant state guidance in planning and a regulatory system that favored low-density development, Mueller challenged the existing rules and regulations to bring its plan to fruition, and develop a public private open space system. Denver's rich heritage in open space planning influenced Lowry, a development challenged with reuse of buildings, as well as decaying, substandard infrastructure and environmental contaminants. The daylighting of Westerly Creek became an organizing element for the plan in both its open space and stormwater management systems. Louisville reclaimed an important segment of its Ohio Riverfront in its development of Waterfront Park. Through its WRO district, it directly influenced the form of its surrounding environment and linkages to downtown. Portland was guided by its strong framework of planning at the state level, and an enduring determination to circumnavigate the Willamette River with pedestrian and bicycle access in its development of the Eastbank Esplanade.

Chapter Five: Austin–Compact and Connected

The previous chapter outlined the framework for planning relative to enabling state legislation in each case study city: Austin, Denver, Louisville, and Portland. Brief descriptions of municipal plans introduced the context for exploration of opportunities and barriers to optimize green infrastructure to promote physical activity. Site plans of selected signature projects accompanied a profile of each project's origin and development, with particular emphasis on multi-functionality and connectivity. The four endeavors represent complexities of multi-phase projects, compounded by a 20-25 year maturation period from inception to completion. The project narratives provided a rich and vibrant background to inform study findings.

Chapters Five through Eight present the study findings, devoting a chapter to each city based on data sets compiled at two scales of analysis: municipal and project. This chapter addresses findings in Austin, Texas. Of particular interest is the ways in which the municipal plans influenced the signature projects, and how these projects may have served as catalysts for city change in response to the research question: how can a green infrastructure network serve as a bridge between planning and public health to realize infrastructure that provides opportunities for human physical activity at the municipal scale? My goal was to identify emergent patterns across the three types of analysis performed: municipal plans, interviews with key participants, and site review and audit of signature projects.

Presentation of findings is generally aligned with research questions, beginning with an overview of patterns detected from site observations. Site reviews of signature projects then illustrate responses to opportunities and constraints, in terms of both regulatory framework and physical site conditions. Data from semi-structured interviews inform analysis at both the municipal and project scale(s). Finally, findings are summarized in response to the research question.

With the planning and construction of a 711-acre (287 hectares) infill project three miles (4.8 kilometers) from downtown Austin, Mueller faced challenges with a land development code oriented for single use traditional zoning. Through a public/private partnership between the city of Austin and the Catellus Development, evolution of the project relied on a core set of principles initiated in the master planning process. Those relevant to this study incorporate compatibility and complementary linkages with surrounding neighborhoods, as well as sustainable development promoting reduced auto dependence and the efficient use, management and protection of resources.

Emerging patterns relevant to research questions include: a lack of holistic methods and procedures to advance green infrastructure; a mixture of conventional and progressive approaches implemented on site; a well planned internal pedestrian and bicycle circulation system; challenges in connectivity in interim phases and to adjacent destinations and neighborhoods; disconnects between policies and codes to implement the plan; and differing perspectives on maintenance practices.

5.1 Municipal Scale Findings

Four municipal plans were evaluated relative to green infrastructure and physical activity. These include: *Imagine Austin* (2012), the comprehensive plan; *City of Austin Watershed Protection Master Plan* (2001); *Austin Parks and Recreation Long-Range Plan for Land, Facilities, and Programs* (2011); and the *Travis County Greenprint for Growth* (2006). Table 5.1 presents a summary of plan evaluation findings.

Table 5.1 Summary of Austin Municipal Plan Analysis

	Imagine Austin Comprehensive Plan (2012)	Parks & Recreation Long Range Plan (2011-2016)	Watershed Protection Plan (2001)	Travis County Greenprint for Growth (2005-2006)	Comments
PLAN CONTENTS					
Authorship (all list public participation as contributing to authorship)	Multiple departments and agencies, including: **parks and recreation**, planning, public works, sustainability, transportation, **watershed protection** represented; health and human services, but not Travis County/Austin Public Health; Citizens advisory task force; several boards and commissions	City parks and planning staff, **watershed protection**; no public health input listed; state and federal park agencies; Travis County planning	Watershed department staff; contributions from **parks and recreation**, public works, transportation **planning and design**, law, public information, neighborhood planning and zoning, office of neighborhood services; no input from public health. Consultants contracted for flood protection, GIS, Hydrologic modeling	Published by Trust for Public Land-project partners included the **City of Austin**, Travis County, TPL and the University of Texas school of Architecture; multiple project stakeholders listed; public health not specifically identified as participant	Participation in plans preparation ranged from city, county, and state levels of government. Public health participation was not listed, except for City of Austin Health and Human Services in ***Imagine Austin***
Clearly stated purpose, goals, and objectives	Plan is outlined in seven building blocks to shape complete community: compacted and connected; policies organized around eight priority programs	Guide for future growth and development of Austin's parks and recreation system with regard to land acquisition, facilities and programs; needs listed by geographic districts	Seven goals toward watershed management, including improving waterways for citizen use and improving urban environment by fostering additional beneficial uses of waterways and drainage facilities	Primary goal focused on identifying available resources, working toward system of parks, recreation and natural areas in the region	Although plans had different purposes, all included goals intended to provide for growth and resource protection. ***Imagine Austin***: Two program areas specifically related to green infrastructure and physical activity: "Use green infrastructure to protect environmentally sensitive areas and integrate nature into the city; Create a healthy Austin program"
Policies related to green infrastructure	Multiple; expanding green infrastructure network to include preserves, parks, trails, stream corridors, green streets, greenways, and agricultural lands	Not specific to green infrastructure, except for ecosystem protection and conservation	Multiple use for contact recreation and aquatic life; Low impact development techniques	Combined community vision for water quality and quantity; recreational opportunities; rare and sensitive environmental resources; cultural resources; consideration of floodplain protection; protection of prairie lands for passive recreation	Policies generally follow goals and objectives; ***Imagine Austin*** list multiple policies for both working and conservation landscapes; terminology for parks uses greenways rather than GI to be consistent with TWPD
Policies related to physical activity	Open space, green infrastructure in terms of need for additional physical land area; parks and recreation gaps in areas to be served	Identification of needs for recreation and gaps in service	Multiple use for contact recreation	Reference to land acquisition for recreation opportunities	Not specific to promotion of physical activity; references to recreational open space and facilities
Policies linked to specific action	Work program identified in two phases for each of seven building blocks: short term (1-3 years), long term and on-going (3 years +)	Needs assessment for future of land, facilities and programs; used to identify gaps in service and leverage funds for bond referendums	Capital infrastructure projects, operating program, and regulatory projects; Tool for decision making	Interactive model to define acquisition needs to support implementation of land acquisition and capital improvement needs regionwide	**Watershed Protection Plan** was first attempt to develop and implement an integrated planning process for watershed protection in the City of Austin. No timeframe for update. References funding needed to update the plan. Greenprint Plan was prepared for adjacent counties following Travis County Plan. Parks and Recreation Plan-no specific date given for update.

Summary of Austin Municipal Plan Analysis, continued

	Imagine Austin Comprehensive Plan (2012)	Parks & Recreation Long Range Plan (2011-2016)	Watershed Protection Plan (2001)	Travis County Greenprint for Growth (2005-2006)	Comments
FACT BASE AND CONTENTS					
Elements Specific to Green Infrastructure and Physical Activity	Current state of Austin addresses performance or non-performance of existing services; emphasis on water quality and protection of sensitive lands; Identification of gaps in park funding for acquisition and maintenance	Conservation, greenways, and physical activity for parks; identification of needs in areas underserved with regard to recreation facilities. Only one specific reference to green infrastructure	Report focuses on solving problems with flooding, erosion control, and reducing water pollution	Identified needs relative to existing inventory conducted for levels of service, park and conservation acquisition needs, and support for implementation of land acquisition and capital improvement needs in the region	Mostly related to performance of existing services, land acquisition for recreation and conservation
Issues addressing multi-functionality and connectivity	Recognition of need for more parkland and proximity of residents to park lands; gaps in sidewalk system	City wide recommendation to increase connectivity; increase connectivity to Mueller Parks and Trails; increase connectivity among city's 40 greenways; ecosystem connectivity with reference to Natural Resources (Austin Nature and Science Center)	Recognition of need for low impact development techniques and protection of watershed(s)	Needs quantified for connectivity between existing city of Austin owned water quality lands; water quality lands in the Colorado River corridor in north and central Austin, as well as along major creeks	References to proximity to facilities (for physical activity) and connectivity; few references state multi-functionality
Integration of green infrastructure into plan	Acknowledges impact of design on public health; Call for development to create walkable and bikeable communities	Limited use of term green infrastructure due to consistency with Texas Parks and Wildlife Department terminology; concept expressed in terms of greenways	Limited use of term green infrastructure	General references to water quality and conservation, as well as recreational needs	Limited use of term in Parks and Recreation Plan (terminology consistency with TWPD)
PLAN PROPOSAL					
Spatial design	Growth concept map identifies need for accessibility by walking; protection of open space; environmental resources for future open space network	Plans included for 27 geographic areas in the city	Watersheds and creeks identified on plans to identify priority areas for improvement	Maps identify priorities for green infrastructure investment (land acquisition)	
Implementation time table	1-3 years (short term) and long term ongoing time frames identified; monitoring with annual reports	Not specified. Plan is used to leverage support for general obligation bonds for future improvements	Planning window 2001-2041; no specific timeframe for implementation	Not stated	Imagine Austin recognized the inconsistencies between policies and codes in terms of bringing projects to fruition. Short term objective to create city green infrastructure plan; long term objective to incorporate green infrastructure development standards in revised LDC and Criteria manuals

Summary of Austin Municipal Plans, continued

	Imagine Austin Comprehensive Plan (2012)	Parks & Recreation Long Range Plan (2011-2016)	Watershed Protection Plan (2001)	Travis County Greenprint for Growth (2005-2006)	Comments
Identification of signature project in plan (Mueller Austin)	Plan states specific projects not listed to focus on citywide concerns; Mueller photos used to illustrate goals for physical activity, town center, compacted and connected, and public/private partnerships for parks	Mueller Parks not officially a part of the Parks and Recreation Long Range Plan; mentions the emergence of public/private partnerships for future projects.	Not referenced.	Not referenced.	
Integration of green infrastructure in plan	Throughout plan (40 + references)	Limited use of term green infrastructure due to consistency with Texas Parks and Wildlife Department terminology.	Limited use of term.		Metrics are still vague for measuring performance. Inconsistency in matching policy objectives: parks proximity vs. acres per capita.
PLAN CONSISTENCY					
Federal and State mandates	Few references to state and federal mandates; cursory references to compliance issues	Areas ranked to comply with Texas Wildlife and Parks Department (TWPD). Recreational, Environmental and Cultural Program Plan in accordance with Commission for Accreditation of park and Recreation Agencies (CAPRA).	Several references to compliance with Federal legislation: Clean Water Act, Endangered Species Act. State: Texas Water Code.	No specific actions listed.	
Coordination with Federal/State agencies	With regard to compliance issues.	TWPD	Listed with regard to Federal Compliance issues.	No.	Focus on compliance, not coordination.
Regional coordination	Plan emphasizes regional coordination, yet not specific in terms of how that might work.	Envision Central Texas Plan, Travis County Greenprint Plan, Austin-Bastrop River Corridor partnership; Coordination with other recreation providers: Lower Colorado River Authority(LCRA), Municipal Utility Districts;	Not specifically stated, but references to collaborative multi-agency partnerships. Not specific.	Each jurisdiction in Travis County has specific ordinances for water quality protection, and general concerns for Texas regulations that my reduce the effectiveness of these measures.	While plans mention regional coordination, no strategies or schedules are referenced.
Coordination among city agencies	Policies are cross references among plan elements in a legible, easy to follow manner.	School District; Austin Comprehensive plan.	Mentions broad goal of collaboration to meet goal, no methods or procedures specified. Recognizes the need to revise city land development code to meet watershed protection goals and objectives.	Document presents case studies in different US cities, does not give specific recommendations for coordination among city agencies, as it is a County plan.	Few methods or procedures states.

The following sections provide a discussion of major findings from plans, combined with municipal scale data and interviews from key participants. Major findings are presented in italic text, followed by discussion for each item.

5.1.1 Perceptions and Patterns of Green Infrastructure in Austin

Descriptions and definitions of green infrastructure in Austin are multiple and varied depending upon disciplinary interests and responsibilities. At the time of data collection, Austin had not adopted a formal green infrastructure plan, however, city organized a green infrastructure cross-departmental working group in 2013 to address green infrastructure issues (Personett 2013; DiGiuseppe 2013; Robertson 2013). Through this working group, staff members stated that the work to date is an evolving plan with a human recreation component. Over 100 items relating existing plans, policies, and programs to green infrastructure were identified for consideration in land development code revisions (Personett 2013). According to one planner, “we are setting the stage for it to occur and people seem attracted.” *Imagine Austin* adoption by the city council and subsequent training program for city staff members on the plan prompted discussion on issues, surrounding the plan, including differing priorities for green infrastructure.

Municipal plan policies address both working and conservation landscapes, yet different municipal agencies prioritize particular aspects of green infrastructure. Although municipal plans reviewed had different purposes, all included goals intended to provide for growth and resource protection. *Imagine Austin* (2012), the city comprehensive plan, lists green infrastructure as one of eight building blocks to guide city growth and development. The plan contains multiple references to green infrastructure policies including preserves, parks, trails, stream corridors, green streets, greenways, and agricultural lands. Interpretations by groups such as urban design, place a higher value on biological systems than engineering systems (Robertson 2013). In discussion of infrastructure elements, one landscape architect expressed concern over a debate that had occurred among city staff in the consideration of trees as infrastructure (Stump 2013). While green infrastructure concepts appear throughout *Imagine Austin*, use of the term in other plans evaluated appears limited. For example, the *Austin Parks and Recreation Long Range Plan for Land Facilities and Programs 2011-2016* (2011) employs "greenways" for consistency with Texas Parks and Wildlife Department terminology. Policies relative to green infrastructure in Austin's Watershed Protection Plan (2001) include multiple uses for contact recreation and aquatic life, and low impact development techniques.

Interviewee responses reflected the distinction between agencies that managed land and those who did not with respect to green infrastructure planning and implementation. Agencies such as Watershed Protection and Parks and Recreation assume responsibilities for the planning, land acquisition, implementation, and management of green infrastructure; planning and public health responses focused on policy issues related to green infrastructure and physical activity. There was, however, general agreement among respondents that the city of Austin places a high level of importance on green infrastructure projects and initiatives.

5.1.2 Relating Green Infrastructure and Physical Activity

Interview responses relating green infrastructure to physical activity were generally favorable, and shared benefits exist. Correlation between mental health and natural areas was cited (Hefner 2013), helping people to connect both physically and emotionally (McCann 2013). As part of Austin's compact and connected theme, "places can be co-located so that they share benefits: trees for shade in a walkable environment" (Robertson 2013). In this way, multiple goals can be met simultaneously.

Policies addressing green infrastructure and physical activity in plans reflect a need for additional physical land area, and identified gaps in service. The gaps in services addressed geographic areas as well as types of recreation services and facilities provided.

5.1.3 Public Health Considerations

Goals for physical activity in municipal plans were largely expressed in terms of recreation and active transportation rather than social determinants of health in the built environment. Health Department staff participated in the development of the comprehensive plan, but not in the authorship in the other three plans reviewed. Imagine Austin contains, as one of its eight building blocks, a "Healthy Austin" component. Designers interviewed expressed concern that site plan approvals usually involved parks and recreation staff "checking off boxes" and that "no public health person has been involved in any projects to date" (Austin 2013). Discussion identified a lack of a holistic approach to promote physical activity.

To address public health from a planning perspective, the city of Austin Planning Department hired two planners through funding from a CDC Community Transformation Grant (CTG) in 2012 (DiGiuseppe 2013; Robertson 2013). It was acknowledged that city staff has embraced support of including public health, yet resources are limited and allocation to date has been superficial. Programs generally depend on grant funding and community needs, resulting in isolated examples to promote physical activity (Deleon 2013). From discussions with city planning staff, the goal is to institutionalize health in planning from precedents set in work accomplished from the CTG grant.

5.1.4 Power and Collaboration

There are few methods or procedures stated to further guide collaborative efforts for policies pertaining to green infrastructure. Although policies pertaining to green infrastructure are cross-referenced among plan elements in the comprehensive plan and list related municipal plans, there does not appear to be a cohesive effort. *Imagine Austin* recognized the inconsistencies between policies and codes in terms of bringing projects to fruition. The short-term objective was to create a city green infrastructure plan; long-term plan was to incorporate green infrastructure development standards in the revised Land Development Code and criteria manuals that delineate procedures by each department for development review (DiGiuseppe 2013). Further clouding of the issue lies in a lack of consistency among the strategic plans prepared by individual departments. While the strategic plan for parks and recreation delineates a specific time frame for meeting its goals to leverage support for future improvements, it suggests that there will be an update to address the next funding cycle. The *Watershed Protection Plan* lists goals and objectives, but the plan has not been updated to address current strategies for green infrastructure, stating such an update would be contingent upon future funding. The incongruence of plan cycles and lack thereof present challenges toward a holistic approach to green infrastructure.

In terms of vertical coordination of plans with federal and state government entities, emphasis was largely placed on compliance rather than collaboration.

References to federal regulation compliance include the Clean Water Act (1972) and Endangered Species Act (1973). Regional coordination was mentioned in plans, particularly the *Travis County Greenprint for Growth*; however, there were no strategies or time frames given for action.

Coordination among departments is mentioned across the plans, but lack of direction exists at the municipal level to advance green infrastructure and physical activity. According to one city planner, "*Imagine Austin* has been viewed as a promising vehicle to encourage interdisciplinary collaboration" (Adams, G. 2013). As an outcome to the comprehensive plan process, interdepartmental groups were formed to address issues organized around themes, in an effort to break down departmental silos. At the time of interviews, training workshops were being held to introduce *Imagine Austin* to city staff, with over 100 managers from 15 departments in its first year (City of Austin 2014). Part of the training for senior staff members included a field visit to Mueller to illustrate compact and connected goals delineated in the plan. While some interviewees felt that formation of cross-departmental teams may help break down the current situation of each department, others disagreed. One landscape architect cited an internal struggle within the city in terms of different professional disciplines and expertise as a 'tug-of-war' at mid and upper level management between landscape architects and engineers: "Engineers have dominated projects as well as the permit process" (Stump 2013). "People don't like change. I don't know that we have mastered the art of collaboration" (Robertson 2013).

Recommendations for future collaboration by key participants drew a mixed response. Recounting successful collaboration made at the project level, one health department staff member offered, "it's important that we need to start connecting the dots" (Deleon 2013). From the developer perspective, better leadership was called for, from both city leaders and agency departmental staff (DesJardin 2013). The wholesale revisions to the Land Development Code, CodeNext, presents the opportunity for cross departmental collaboration to address the apparent mismatch between policies endorsing compact and connected growth and development, and an existing land development code designed for a typical project programmed for a single use on a specific parcel of land.

5.1.5 Measurement

Based on those interviewed, there was a consensus that measurements of green infrastructure and physical activity should be documented. Conversely, what should be measured varied by participant, with responses from documenting connectivity of sidewalks to commuter behavior to performance measures in health impact assessments. Challenges exist in both the availability and consistency of data to meet the performance indicators outlined in Imagine Austin.

Responding to the importance of replicability of a project's best practices, one planner voiced that data collected should be used to advocate policy at the local level, similar to data from the BRFSS utilized to promulgate policy at the state level. In terms of physical activity, the difficulty of documenting positive outcomes for physical activity has been challenging (Deleon 2013). One planner expressed frustration with comparisons of physical activity research to tobacco cessation. Other responses included a lack of direction of what should be measured.

I argue that performance indicators are often prescribed with little or no thought to how they will be measured in view of meeting policies envisioned. *Imagine Austin* prescribes a broad array of performance indicators among its eight sections of the plan, yet little direction exists in definition of criteria for evaluation.

5.2. MUELLER AUSTIN: SIGNATURE PROJECT FINDINGS

The RMMA Development Process and Goals Task Force report (1996) envisioned the concept for Mueller as "an unparalleled opportunity to make a case for innovative growth" in the creation of a pedestrian oriented mixed-use community. The master plan for Mueller afforded the opportunity to aggregate open space as a cohesive system for both working and recreational green infrastructure (Hefner 2013). Construction of aggregated infrastructure improvements were mandated by the city approved Master Development Agreement in 2004. These include: streets, detention, water, wastewater, reclaimed water and water quality components to be in compliance with the local Land Development Code. Initial phases include the stormwater management areas, as well the centrally located Lake Park near the proposed town center. Green infrastructure solutions employ a combination of innovation and convention. In working toward its goal to be compact and connected, Mueller has experienced a mixture of opportunities and barriers.

5.2.1 Green Infrastructure at Mueller

According to Dee DesJardin, marketing and communications director for master developer Catellus, *green solutions appear conventional in some respects, but an attempt was made to blend the connectivity of green infrastructure in a thoughtful way*. Although green infrastructure was addressed in the plan at the building/lot, neighborhood, and development levels, this study focuses on the open space system and its components at the development scale. Conventionally, portions of parks and open space areas occupy the 100-year floodplain, serving a dual purpose for flood control and recreation. Conversely, Mueller operates as a 'living lab' (DesJardin 2013). Community stormwater treatment areas were designed as public amenities (Mueller Design Book 2004, 119), while reclaimed water supplies irrigation needs for the 15,000+ trees planted at Mueller's ultimate build out (Adams, G. 2013; Adams, J. 2013; Austin 2013). This includes an orchard of fruit trees in the Southeast Greenway along the site perimeter. (Mueller Green Book, 2004 as amended). Innovative strategies involved collaborating with the Lady Bird Johnson Wildflower Center in the restoration of a Texas blackland prairie incorporating native plants in the Southwest Greenway, and rain gardens contributing to the system of stormwater management areas and lakes that harvest and cleanse stormwater and retain water onsite. These innovations, however, were not accomplished without challenges.

There was a resistance by the city of Austin "to maintain something new and different," according to project landscape architect Barbara Austin. Rain gardens had not been successfully established in the central Texas area, with positive examples located in regions receiving higher annual levels of precipitation. Without local precedence, a license agreement was required before the permit could be approved. The license agreement places the burden of maintenance on the developer, and developer must bear costs of any materials that need to be replaced.

Environmental issues with water sources and water quality created some 'less than green' solutions. The use of reclaimed water for irrigation presented concerns by permitting agencies for possible cross-contamination with potable water supply (Austin 2013). This resulted in repeated testing and additional coordination for placement of water related amenities, such as the pond in Lake Park. To maintain the water level, a clay liner was placed at the bottom of the pond, and recharged with potable water

(Adams, G. 2013). Due to water quality concerns, water dependent recreation activities such as wading and small-craft boating were prohibited (Austin 2013; Hefner 2013).

To retain stormwater on site in ponds, the stormwater management system implementation included a dam structure along the Southwest Greenway. As stipulated in the requirements of the Planned Unit Development conditions of approval, no tree planting was allowed on pond banks and berms around the dam. The restriction created open areas without shade in parts of the greenway trail.

5.2.2 Interim Challenges to Multi-Phased Development

Compact and connected concept relies on a planned, yet unbuilt transit system to encourage walking. At the time of site observation and fieldwork in April 2015, Mueller was approximately 40 percent complete. Development patterns generally follow the master plan and requirements as prescribed in the Mueller Design Book. One notable exception is in meeting the goal for a transit-based community. While the corridor has been reserved for connection to a proposed rail and rapid bus system, Mueller has not yet been able to deliver on a promise of putting its majority of residents and employees within a 10-minute walk of transit. Figure 5.1 depicts the Mueller Pedestrian System as of April 30, 2015, delineating parcels not yet developed or under construction.

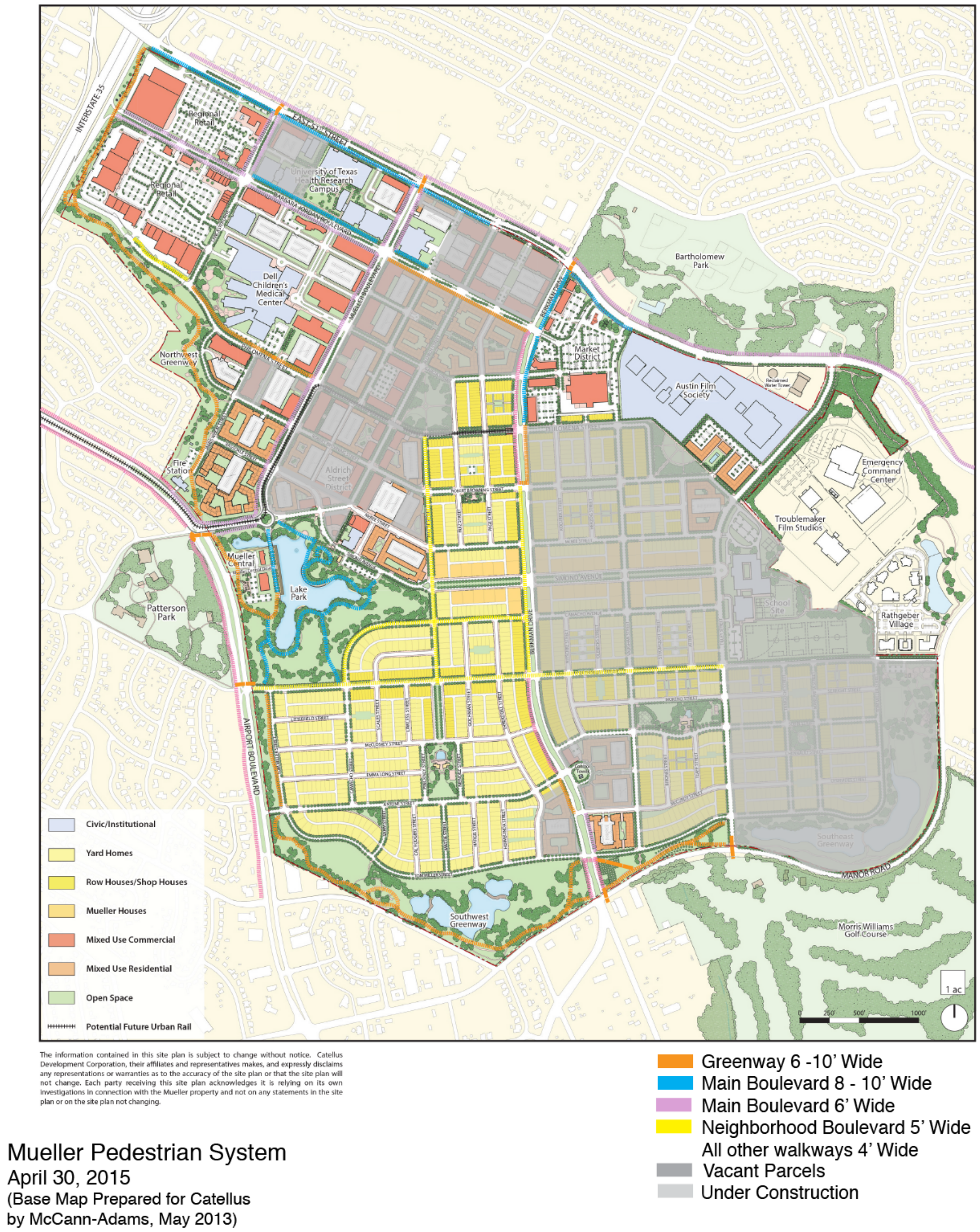

Figure 5.1 Mueller Pedestrian System Map

While the goal of Mueller is one of a compact community with well-connected pedestrian system, the interim state has experienced conditions similar to those plagued by traditional Euclidean zoning. Gaps exist in walkways planned for vacant parcels, and the few temporary walks constructed along major roadways lack shade. Walking to destinations such as the Thinkery Children's Museum and HEB grocery store is, in some locations, hindered by disconnects through undeveloped parcels.

Figure 5.2 Walkway disconnect at main roundabout

This condition contrasts with walkways in adjacent property of completed development, as illustrated in Figure 5.3.

Figure 5.3 Completed walkway segment

Like the pedestrian system, bicycle facilities at Mueller suffer from interim conditions through a yet to be completed combination of bike lanes, shared ‘sharrow’ marked traffic lanes, and cycle tracks. While city bicycle routes are well marked on the project periphery, orientation within Mueller is inconsistent in terms of signage to orient cyclists.

Site observations are more fully discussed in conjunction with site audit/evaluation.

5.2.3 Site Audits: Evaluating Multi-Functionality and Connectivity

Two types of audit tools were utilized in conducting site analysis of multi-functionality and connectivity: New York City’s Center for Active Design (CfAD) Urban Design Checklist, and the Physical Design Strategies Checklist (Winslow 2010).

Initially, site review employed the Center for Active Design (CfAD) Urban Checklist, identifying major urban design features present for the overall development, with specific emphasis on connectivity within the project and to adjacent sites identified in the master plan. The Physical Design Strategies Checklist was used as a tool to assess the presence of physical design characteristics and green infrastructure elements for six recreation sites within Mueller.

Based on site observations performed in April 2015, CfAD guidelines were generally implemented in terms of parks, open spaces and recreation facilities. Completed CfAD Audit is depicted in Table 5.2.

Table 5.2 Mueller CfAD Audit

CENTER FOR ACTIVE DESIGN

MUELLER AUSTIN SITE AUDIT and EVALUATION
April 25 - May 2, 2015

CHECKLIST URBAN DESIGN

● Indicates Item addressed or present on site.
Additional comments are shown in italics.

2.1 LAND USE MIX

● When Planning for urban scale developments, provide for a mix of uses - for example, residences, offices, schools, retail stores, cultural and community spaces, and recreational facilities.

● Locate places of residence and work near destinations such as parks, walking paths, trails and waterfront recreation areas.

● Develop supermarkets and full service grocery stores near places of work and residence.
**Grocery store and commercial areas provided, but autocentric in orientation, and drive thrus dominate circulation.*

2.2 TRANSIT AND PARKING

● Locate buildings and building entrances near public transit stops and along transit corridors.

● Place public transit stops along well-connected streets.**Few stops in residential areas, inadequate shelter.*

○ Provide signage at buildings, transit stops, and major intersections showing a map and the distance, time, route and calories burned to the nearest or next transit stop.

○ Encourage transit use by furnishing transit stops with pedestrian conveniences.**Inconsistent*

□ Make sidewalks wide enough to comfortably accommodate pedestrians, including those with disabilities **Sidewalk widths vary. 4' sidewalk inadequate to accomodate two people passing with strollers, walking dogs.*

□ Provide additional space for passengers to wait by adding bus bulbs. **Provided on some stops*

□ Create bus stop shelters that protect the users from sun, wind, and rain **Provided on some stops*

□ Furnish bus stop shelters with seating or places to lean. **Provided on some stops*

● When designing sites that include parking, consider how the provision of parking can affect the use of more active modes of travel such as walking, bicycling, and public transit.

● Provide parking for people with disabilities

2.3 PARKS, OPEN SPACES, AND RECREATIONAL FACILITIES

● Design open spaces as part of large -scale developments, or locate buildings near open, public spaces.

● Make bicycle and pedestrian routes to parks and public spaces safe and visible. **inconsistent on bike routes.*

● When planning a new development. Aggregate open space in one large area rather than dispersing into smaller pieces. Where possible, provide residents with access to open space within a ten-minute walk.

● In the design of parks or open spaces, provide paths, running tracks, playgrounds, sport courts, and drinking fountains. **not all drinking fountains were 100% operational at time of evaluation.*

● Locate new projects near existing public and private recreational facilities and encourage development of new facilities, including indoor activity spaces. **Access to adjacent parks not most direct routes for pedestrians and bicyclists.*

● When designing offices and commercial spaces, provide exercise facilities or walking paths nearby.

● Design parks, open spaces, and recreational facilities to complement the cultural preferences of the local population, and to accommodate a range of age groups.

● Create partnerships with organizations to sponsor and maintain green spaces and gardens.

2.4 CHILDREN'S PLAY AREAS

CENTER FOR ACTIVE DESIGN

MUELLER AUSTIN SITE AUDIT and EVALUATION
April 25 - May 2, 2015, continued

● Design courtyards, gardens, terraces, and roofs that can serve as outdoor spaces for children's play
**No terraces or roofs observed as outdoor spaces for children's play*

○ When designing playgrounds, include ground markings indicating dedicated areas for sports and multiple use.

○ Preserve or create natural terrain in children's outdoor areas.

● Provide lights on sidewalks and active play areas to extend opportunities for physical activity into the evening.

● In the design of parks and playgrounds, create a variety of climate environments to facilitate activity in different seasons and weather conditions.

○ Provide physical activity facilities for children and youth in schools **not applicable*

○ Design new school physical activity facilities to potentially allow for public use outside of school hours.
**not applicable*

2.5 **PUBLIC PLAZAS** **Only Plaza observed located at Lake Park near Mueller Central*

● Create attractive plaza spaces that are well-maintained.

● Locate public plazas along popular pedestrian streets. **Near Mueller Central and Lake Park*

○ Locate plazas near transit stops.

○ Make plazas accessible to bicyclists.

○ Create plazas that are level with the sidewalk.

● Design plazas that allow for diverse functions

● Design plazas to accommodate use in a variety of weather conditions.

○ Seek partnerships with community groups to maintain and program plazas. **not applicable*

2.6 **GROCERY STORES AND FRESH PRODUCE ACCESS**

○ Develop full-service grocery stores within walking distance in all residential neighborhoods. **not measured from all areas*

● Introduce farmer's markets as a complement to grocery stores.

● Provide safe walking and bicycle paths between densely populated areas and grocery stores and farmer's market sites.

○ Design grocery store layouts and parking to accommodate pedestrian, cyclist, automobiles, and loading trucks safely and conveniently. Provide infrastructure such as bicycle parking a drinking fountains.
**While accomodations are made for pedestrians and bicycles, preference and convenience is given to automobile traffic and parking.*

2.7 **STREET CONNECTIVITY**

● In large-scale developments. Design well-connected streets with sidewalks and keep block sizes relatively small.

○ Where current connectivity of sidewalks and streets on a building site is poor, provide pedestrian paths through existing blocks. **Interim pedestrian connections are inadequate in most areas, except for access along B.Jordan and Berkman.*
Avoid creating pedestrian over- and underpasses that force walkers to change levels.

○ Maintain dedicated pedestrian and bicycle paths on dead-end streets to provide access even where cars cannot pass.

● Minimize addition of mid-block vehicular curb cuts on streets with heavy foot traffic.

● Design vehicular driveways and ramps to minimize contact between cars and pedestrians. **Use of alleys minimizes curb cuts along street network sidewalks.*

2.8 **TRAFFIC CALMING**

● Design roads to be minimum width and to have the minimum number of lanes practical.

● Incorporate traffic calming street additions such as curb extensions, medians, and raised speed reducers.

○ Consider other physical design measures where appropriate, for example:
□Horizontal deflections such as curved roadway alignments 'Vertical deflections such as raised intersections or crossings
●Traffic diverters, roundabouts, and mini-traffic circles

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CENTER FOR ACTIVE DESIGN

MUELLER AUSTIN SITE AUDIT and EVALUATION
April 25 - May 2, 2015, continued

	◻Signal phasing plan with a protected left-turning lag phase ◻"Yield to Pedestrian" signs ◻Avoidance of slip lanes and wide curb radii
2.9	**DESIGNING PEDESTRIAN PATHWAYS**
	● Create a buffer to separate pedestrians from moving vehicles using street furniture, trees, and other sidewalk infrastructure.
	● Provide seating, drinking fountains, restrooms, and other infrastructure that support increased frequency and duration of walking. **not all drinking fountains opeational at time of evaluation*
	● Provide exterior lighting along streets and outdoors paths.
	● Include trees and objects of visual interest on streets and sidewalks.
	● Make sidewalk widths consistent with their use. **fit to street template and available rights of way as much as use.*
	○ Provide for enhanced pedestrian crossings both at mid-block and at intersections.
	● Construct curb extensions along sections of the sidewalk that tend to attract greater pedestrian congestion. **at Lake Park and Thinkery location(s).*
	● Create or orient paths and sidewalks toward interesting views.
	○ Provide marked, measured walking paths on sites as part of a way finding system targeted to pedestrians and bicyclists. **only along perimeter greenways.*
	● Make streets and paths universally accessible. Create: ◻Paths that are smooth, sufficiently wide, and that have curb cuts and turning radii adequate for a wheelchair or walker. ●Paths with auditory crossing signals, adequate crossing time, clear signage , visible access ramps, and connections to walking, cycling and public transit routes.
2.10	**PROGRAMMING STREETSCAPES**
	● Incorporate temporary and permanent public art installations into the streetscape.
	● Organize pedestrian-oriented programs, such as charity walks and vehicular street closures, that make wide avenues available for walking and bicycling.
	○ Increase the number of outdoor cafes to enhance street activity.
2.11	**BICYCLE NETWORKS AND CONNECTIVITY**
	○ Design interconnected bikeways and establish a backbone network of unbroken through routes. **bicycle network incomplete at time of evaluation.*
	○ Make links between bicycling and transit.
	○ On bikeways, include signposts providing bicyclists with directions, distances, and times to various destinations.
2.12	**BIKEWAYS**
	○ Use on-street markings or signage to visually reinforce the separation of areas for bicyclists and motorists. **bikeway network still under construction at time of evaluation.*
	○ Where conditions warrant, separate bikeways and vehicular traffic lanes with physical demarcations.
	○ Expand existing bikeways where use has exceeded capacity
	○ Pay special attention to the treatment of bikeways at intersections and other points where the street form changes, in order to mitigate potential visibility issues and turning conflicts.
	○ Avoid potential conflicts between cyclists and opening car doors - for example, by widening parking lanes where appropriate.
	● Further develop Greenways - alternate routes that are integrated into the regional park system. **at time of evaluation, greenways were onsite with limited connectivity to other park areas (poor and indirect access to Bartholomew Park*
	○ Consider shared-use paths in areas with viewing attractions.
2.13	**BICYCLING INFRASTRUCTURE**
	● Provide adequate facilities for bicyclists to park along their route or at a final destination.

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CENTER FOR ACTIVE DESIGN

- ◯ Designate bicycle-specific crossings and signals to organize the movements of pedestrians, cyclists, and motorists at busy intersections.
- ◯ Construct bicycle share programs to increase access to bicycles for both city residents and visitors.

Overall, Mueller demonstrates a concentrated effort in the integration of open space and infrastructure systems. As previously referenced, green infrastructure site solutions appear fairly conventional in contrast with building technology employed in both residential and commercial structures with regard to green building goals. Configuration of completed segments of the project support the proximity of open space to residences as prescribed in the Mueller Design Book, contributing to the connectivity of the pedestrian network.

Bicycle and pedestrian facilities at Mueller consists of two separate, but connected systems. One aligns with the hierarchy of the street network; sidewalk widths (four to twelve feet, or 1.2 to 3.7 meters) correspond to street type such as arterial, collector and neighborhood streets. The second consists of ten feet wide (3.0 meters) minimum multiple use trails along the perimeter greenway/stormwater management corridor. At the time of fieldwork, the perimeter trail extended from the northwest greenway at 51st Street to the intersection of Tilley and Manor Streets in the Southeast Greenway. Trails were found to be in good condition, and ground level sign monuments indicate distance travelled in ¼ mile (0.4 kilometer) intervals. Street trees align most corridors, and trees are clustered along the trails to provide shade, with the exception of the segment adjacent to the stormwater control dam structure. Mode separations between pedestrians and cyclists are not marked consistently throughout the community. Alleys promoted safe and level walkways (McCann 2013) throughout the residential neighborhoods by providing parking and vehicular storage at the rear of residential units, creating additional pedestrian circulation space, and alleviating the need for multiple curb cuts on neighborhood streets.

Pedestrian connections to adjacent destinations and neighborhoods remain incomplete. The Mueller master plan was charged to compensate for existing deficiency in parks and open space, and connect with 16 surrounding neighborhoods, as outlined in the Mueller Design Book. Connections were planned for adjacent parks and recreation sites: Bartholomew Park to the north, Patterson Park to the west, and Morris Williams Golf Course located directly south of Mueller. While sidewalk connections have been made to the parks and golf course, user comfort and safety continue to be challenged by the heavy volume of traffic on Airport Road and 51st Street. This is compounded by the autocentric layout of intersections and the market district.

Although the market district employed green technology in buildings (McCann 2013), the layout demonstrates a preference for automobile circulation through its drive thru facilities, where pedestrian circulation appears secondary and there is little space allocated for gathering or informal activities. This contradicts public meeting records, which indicated a willingness of nearby residents to walk to the grocery store (McCann).

Site observations and audits found most facilities portrayed a generally well-connected system for pedestrians in terms of legibility and connectivity. This was evidenced through the physical design strategy analysis to the onsite parks.

The evaluation of park sites found most strategies had been employed on Mueller parks and recreation areas in terms of access, comfort and safety, and active engagement. Area deficiencies appeared in the lack of facilities co-located for parent/child activities, and in the lack of lighting on greenway trails that are open to the public until 10:00 p.m. Table 5.3 presents a summary of site observations for the six parks.

Table 5.3 Mueller Physical Design Strategies Audit

Inventory: Physical Design Strategies on Case Study Projects
City: AUSTIN
Mueller Austin
Conducted April 25 - May 2, 2015

■	Indicates item is present on site
▒	Indicates some items present or item not adequately represented on site
n/a	Item not applicable to specific site
	Indicates item not present on site

		Location: Lake Park	Ella Wooten Park	Paggi Park	NW Greenway	SW Greenway	SE Greenway
Access							
Legibility	Ease of movement throughout activity areas in the park	■	■	■	■	■	■
	Clearly visible and multiple access modes to the park	■	■	■	■	■	■
	Respectful of terrain	■	■	■	■	■	■
Coherence	Separation of Traffic Modes - car, bicycle, pedestrians, transit				■	■	
	Aggregation of open space in large central area	■	■	■			
Tidiness	Trails with good surfaces	■	■	■	■	■	■
	Provision for areas made for sun in winter, shade in summer	■	▒	■	■		■
Connectivity	Trail connections to offsite trails and parks	■	▒	■	■		■
Context	Neighborhood access encourages park use	■	■	■	■	■	■
Comfort and Safety							
Legibility	Safe and visible pedestrian and bicycle routes within the park	▒	■	▒	▒	▒	
	Benches	■	■	■	■	■	■
	Restrooms - location and proximity to use areas	■	■				
	Drinking Fountains - location and proximity to use areas	▒	▒	■	■	■	
Coherence	Lighting on Trails and Activity Areas for Extended Use						
Complexity	Effective Use of Native Materials, establishment of identity	■	▒	■			■
Tidiness	Condition of Facilities and Equipment	■	■	■	■	■	■
	Little or no evidence of debris, litter	▒	■	■	■	■	■
Active Engagement							
Legibility	Centrally visible activity spaces	■	■	■	■	■	■
	CONTEXT, proper orientation for sports courts, etc.	n/a	■		n/a	n/a	n/a
Context	Location of park relative to other existing public/private facilities (co-located for shared resources)	■	■	■	■	■	■
Diversity	Multiple facility types and uses provided	■	■		■	■	■
	Flexible Open Space Provided	■	■	■	■	■	■
Complexity	Facilities co-located to optimize simultaneous p/c activities				■		
	Motivational decision prompts placed to encourage mobility				■		■
	Curvilinear roads and paths	■			■	■	■
Connectivity	Connection to multi-use paths	■	▒		■	■	■
	Marked distance trails				■	■	■
Discovery/Fun							
	Different Experiences created for road and path users	n/a	n/a	n/a	n/a	n/a	
	Create or preserve natural terrain in children's play areas			n/a	n/a	n/a	
Green Infrastructure Elements/lands							
Park		■	■	■	■	■	■
Open Space		■	■	■	■	■	■
Stormwater Management Areas		■	■	■	■	■	■
Street Trees/street right of way		■	■	■	■	■	■
conservation area							
other							
urban agriculture/fruit trees		■			■	■	■
native prairie habitat						■	■

5.2.4 Public Health Considerations

According to the project director for Mueller, there was no conscious requirement for promoting public health during planning and design of the project, and no interaction with the Public Health department with regard to promoting physical activity. The Mueller Design Book (2004) prescribed an interconnected system of open spaces and pedestrian ways to promote walkability, with site infrastructure intended to endorse principles of sustainability. From the city staff perspective, "Mueller got a fair amount right from the public health point of view, but I'm not sure we thought of it explicitly as public health" (Robertson 2013). There did not appear to be a strong connection at the time that linked physical activity to public health by project participants, similar to findings at the municipal level. Providing pedestrian connections and accommodating user comfort elements such as shade along walkways were addressed as green infrastructure elements components contributing to sustainable urban design.

5.2.5 Power and Collaboration

Although policies generally support principles of green infrastructure at the municipal scale, departmental and disciplinary silos presented challenges at the project scale. As one planner in code enforcement stated, "Mueller broke a lot of rules getting through the system" (Adams, G. 2013). According to the Planned Unit Development (PUD) documentation at the city of Austin,[49] over 100 items were identified in code violations that had to be changed to implement the master plan for Mueller. The administrative rules in the PUD address supplemental information on the standards for

[49] Ordinance No 040826-61-PUD, 2004 as amended

streets and streetscapes, drainage, and landscaping. These standards guide the review and approval of subdivision plats, infrastructure construction plans, and site plans. Highlights of alternate compliance due to the 'urban nature of the project' include: tree yards adjacent to streets and sidewalks, with trees located a minimum of 3' 9" (1.1 meter) from the face of curb; allowance of bicycle lanes in roadways in which parking is prohibited; use of alleys for loading; narrower street widths; and aggregation of landscaping in street yards, parking lots, and buffering in select areas of the project.

Key project participants-City of Austin, Catellus, consultants, and community members brought forth new ideas to try at Mueller. According to Dee DesJardin, the city participated in code changes as a willing partner to implement necessary modifications. Project planner Jana McCann credited project successes to a "huge amount of collaboration among people involved in the PUD" with key collaborators discussing "what rules are we going to bend, what new things can we do not in code?" One of the project's strength's lies in its history of collaboration (Hefner 2013). Partnership and public outreach began in the 1990s,[50] and the consulting team experienced consistent leadership and participation from project inception through multiple phases of implementation. Support from progressive neighborhood leaders in the project vicinity was cited as being critical to showcase new sustainable patterns for Austin, and gain support from city council. As Jim Adams explained, "City council never would have gone for this (project) without that support." Having the guiding principles for Mueller, and viewing them as non-negotiable, helped in the decision-making. Working through the challenges in design and approval of this public/private partnership, however, did not solve impending issues regarding maintenance responsibilities.

[50] www.muelleraustin.com/about/history

5.2.6 The Politics of Maintenance

As a public/private partnership, the open space system at Mueller is 100 percent open to all residents and visitors. Responsibilities for maintenance are shared between the city of Austin and Catellus, as outlined in the *Mueller Master Development Agreement* (MDDA), completed in 2004. The Mueller Master Community assumes responsibility for the operation, maintenance programming, and associated improvement of identified common elements at Mueller, including: community pools; neighborhood parks, greenways and trails and other open space; town center community amenities, and medians of major arterial roadways. The city fulfills its obligation in an annual payment contribution consistent with its level of maintenance in other city maintained public open space (MDDA 2004, 67). *Austin Parks and Recreation Long-Range Plan for Land, Facilities, and Programs* cites this new concept as a potential model for future park maintenance (MDDA 2004, 216).

Another issue addressed in the MDDA pertains to license agreements for maintenance. City mandates such an agreement when non-standard uses encroach on public property. At Mueller, even though the PUD allowed non standard uses in its administrative rules, the city required license agreements for landscape maintenance in areas where additional amenities exceeded code requirements. According to Barbara Austin, "the city does not want to maintain anything more or anything different than status quo." Similar to the rain gardens, if the city has to dig up the street corridor for utility repairs or replacements, the developer must replace and repair amenities at his cost.

5.3 Summary

Mueller presents itself as a catalyst for change in Austin, appearing throughout the city's new comprehensive plan as a representative model for a compact and connected community. The public/private partnership approach for funding and operation of green infrastructure maintenance has been cited for its potential in future projects. The preparation and adoption of the *Imagine Austin* and CodeNext land development code revision process subsequent to the plan approval and construction at Mueller presented an opportunity to evaluate the opportunities and challenges in view of current policies and code requirements at each juncture in the regulatory framework. Mueller, and other projects, brought attention to the challenges of obtaining permits for projects advocating progressive and innovative strategies represented as code violations. City planners have viewed the comprehensive plan as a promising vehicle to encourage interdisciplinary collaboration, yet others cite the continuing difficulties experienced in interdepartmental coordination. Although progress appears to be made in terms of cross-departmental task teams to address issues, different departments have their own goals, and conflicts arise (Adams, G. 2013).

Chapter Six: Denver–Infill Integrating History

Study findings for Denver, Colorado are presented in this chapter at both the municipal and project levels. Following the format established in the previous chapter, presentation of findings is generally aligned with research questions–beginning with an overview of patterns emerging from review of municipal plans and perceptions of interview respondents at the city scale: perceptions of green infrastructure, as well as how it relates to physical activity; issues of power and collaboration; and perceptions as to what items should be measured for green infrastructure that promotes physical activity. A summary of the analysis for Lowry follows, integrating information obtained from site observation, site audits, and interviews of key participants.

As one of the largest urban infill sites in the United States, Lowry confronted substantial obstacles in converting an 1890-acre (765 hectares) military base into a new mixed-use community. From its inception, the project outlined several goals to guide design and implementation. Those relevant to green infrastructure and physical activity consist of: urban design and on site components integral to regional open space; trail system, and parkways; and urban wildlife habitat. The *Lowry Reuse Plan* (1993) built upon the foundation of these principles, and envisioned the plan to be an extension of and supporting element for the local comprehensive plan. *Design Guidelines for the Lowry Community* (amended 2008) followed. Prepared by the Lowry Redevelopment Authority (LRA), a quasi-governmental entity charged with managing the design and implementation of the project, standards set forth requirements and delineated governance control of guidelines and local government regulations.

While key participants in the interview process concurred with the strength and consistency in planning policy, translating visionary goals into finished products produced considerable challenges. Emergent patterns pertinent to the research questions include: a lack of holistic methods to advance green infrastructure; a disconnect between policies that advocate green infrastructure and codes that prohibit innovative design strategies; a disagreement between the principles of City Beautiful in Denver's strong park heritage and contemporary best practices for design and maintenance; and difficulty in realizing connectivity to other sites and destinations.

6.1 MUNICIPAL SCALE FINDINGS

The structure of planning in Denver has been described as an "ecology of plans" consisting of a coordinated set of documents, in this instance from the project to the city scale, where each related functional plan relies on the other plans (Godschalk 2004, 9). Evaluation of municipal plans commenced with *Denver Comprehensive Plan 2000* (2000), the keystone of Denver's plan hierarchy, followed by three functional citywide plans with respect to applicability of green infrastructure and physical activity. These consist of: *The Game Plan* (2003), a long-range plan for Denver Parks and Recreation; *Water Quality Management Plan* (2004), addressing water quality and treatment; and *Greenprint Denver* (2006), advocating sustainable land use practices throughout the city.

Policies are clearly stated in terms of goals and objectives across the plans evaluated. Documents are extensively cross-referenced, with emphasis placed on the importance of interface between departments in the city. The complexity of federal and state requirements is fully described. Structure of plan order is consistent in supplemental citywide plans as well as small area plans, such as Lowry.

Common threads among plans focus on provision of parks and recreation areas, tree planting, and frameworks for future needs. Table 6.1 provides a summary of plan evaluation findings.

Table 6.1 Denver Municipal Plan Analysis

	Denver Comprehensive Plan 2000 (2000)	The Game Plan (2003) Parks and Recreation	Water Quality Management Plan (2004)	Greenprint Denver (2006)	Comments
PLAN CONTENTS					
Authorship (all list public participation as contributing to authorship)	Not specifically listed in plan	Interdepartment involvement was key component of preparation; Combination of city departments and consultant team	Wastewater management division of Denver Public Works, with participation from multiple entities listed including city departments and consultants	Greenprint Denver staff, with input from multiple city departments and Matrix Consulting	Environmental health referenced as participant in all four plans; parks, community planning and design
Clearly stated purpose, goals, and objectives	Plan organized around four guiding principles, including: environmental stewardship of natural resource, equity for a high quality of life; economic opportunity; and engagement to build collaborative partnerships	Five broad themes: new parks in new places; Colorado landscape in the city; responding to new needs and trends; transforming open space into green infrastructure; and connecting the public realm	Four main goals: shared vision to meet stormwater quality requirements; develop BMP strategies; interdepartment understanding of stormwater requirements and role in planning process; framework for future needs	Purpose of plan is to integrate sustainable practices in city programs, catalyze innovation, and portray value of sustainable development as core value	All have clearly stated goals and objectives, green infrastructure listed in parks
Policies related to green infrastructure	Policies not specific to green infrastructure, but does mention green connections for trails, bike routes, parkways, greenways, and watercourses	Green infrastructure as means to integrate public open space with other infrastructure	No specific use of term green infrastructure	Plant trees on both public and private property to increase Denver's tree canopy from 6-18% (as identified in parks master plan)	Tree planting and green infrastructure
Policies related to physical activity	Term physical activity not present, but goals listed pertaining to bicycling and walking as alternatives to automobiles	No specific reference to physical activity; walkability and bikability mentioned	No specific reference to term physical activity	Walkability: canopy of street trees to establish network of public spaces for residents to enjoy urban landscape as healthy ecosystem	Walkability discussed in most plans, tree canopy

Denver Municipal Plan Analysis, continued

	Denver Comprehensive Plan 2000 (2000)	The Game Plan (2003) Parks and Recreation	Water Quality Management Plan (2004)	Greenprint Denver (2006)	Comments
Policies linked to specific action	Summarized as one page at end of plan; none specific to green infrastructure or physical activity; references to plan supplements	Addresses three scales: neighborhood, citywide, and region; Increase tree canopy	By description, time frame in years, lead department, and estimated funding level		Varies across plans
FACT BASE AND CONTENTS					
Elements Specific to Green Infrastructure and Physical Activity	Not specifically; identifies current park resources	Access issues due to major roadways; negative impacts from non-native plants		Lists strong foundation of past achievements	Access, park resources past and future
Issues addressing multi-functionality and connectivity	Conflicts between transportation needs and walkability	Trail connectivity shown on network plan		Walkability	Accessibility
Integration of green infrastructure into plan	Park heritage and parks and parkways referenced	Map shown of existing parks and open space system, and adjacencies necessary for access		Reference to tree canopy	History and heritage of parks and parkways, access, tree canopy
PLAN PROPOSAL					
Spatial design	Map illustration of parks and parkways shown. No future land use plan to indicate how goals may be realized	Proposal	No specific references to green infrastructure or physical activity	Green infrastructure centered on Parks Master Plan and Denver Water Board Integrated Resource Plan	Emphasis on parks and recreation areas
Implementation time table	Yes, but no hierarchy or priorities listed	Time frame of plan is to guide decisions for planning and development through 2053	Policies linked to specific action by description, time frame, lead department, and approximate funding level	2011 for implementation of expanding natural landscape goals	Contingent on individual plans

Denver Municipal Plan Analysis, continued

	Denver Comprehensive Plan 2000 (2000)	The Game Plan (2003) Parks and Recreation	Water Quality Management Plan (2004)	Greenprint Denver (2006)	Comments
Identification of signature project in plan (Lowry)	Lowry referenced throughout plan for impact to urban growth, and as one of Denver's major urban centers.	Contribution to open space system; water conservation	Example of project demonstrating sustainable development	No	Lowry referenced among plans, except greenprint plan
Integration of green infrastructure in plan	No specific references given.	Targets Lowry for development of new natural areas.	Plan reviewed national case studies in Portland, Austin and 3 other cities	Tree planting, reduction of carbon footprint.	Particularly in terms of open space
PLAN CONSISTENCY					
Federal and State mandates	Not specifically referenced	Compliance with state laws	Complex state and federal requirements discussed	Not referenced	More regulatory compliance, good job of describing the complexity of state and federal requirements
Coordination with Federal/State agencies	Coordination with state agencies well documented	Referenced throughout plan	Compliance, not coordination	Not referenced	On local and state level
Regional coordination	Well documented	regional recreation needs	Other documents referenced	Not referenced	Good in three out of four plans
Coordination among city agencies	Only with regard to parks and greenways. Structure of plans consistent, supplemental citywide plans as well as neighborhood plans. References updated land use code	Listed throughout plan	Importance of interface between departments	Parks Game Plan and Water Quality Plan	Good job between plans of cross referencing, as well as emphasizing the importance of interface between departments in the city

The following sections provide major findings from plans, integrating municipal scale data and interview responses from key participants. Additional documentation emanated from materials referenced or distributed during discussions with interviewees. Major findings are presented in italic text, followed by discussion for each.

6.1.1 Perceptions and Patterns of Green Infrastructure in Denver

Green infrastructure in Denver shares a high awareness level among respondents, yet varies in its descriptions and perceived levels of support. Most interview participants stated that Denver places a high level of importance on green infrastructure. "I think it's embraced. A lot of things that we have done in Denver that have been innovative in terms of green infrastructure and emphasis on really high quality public demand, have become models for other parts of the country" (Johnson 2013). Others recognized its importance, but questioned its overall reach, "I do think the city has made a commitment…it's still sort of in those high level policy stages more so than being activated in every single plan" (Barkey 2014). Departmental silos were identified by LRA director Monty Force, "You could probably get 100 opinions on how they view [green infrastructure] depending on which department you are talking to." With varying interpretations of the concept, interview data and planning documents suggest a lack of a holistic approach to green infrastructure, with each department focused on particular aspects.

The evolution of green infrastructure continues. *Greenprint Denver* (2006) lists past accomplishments such as tree planting as a strong foundation on which to build future efforts. Steve Gordon, director of planning services, cited the different departments working on various components of green infrastructure as an advantage, a vehicle to build relationships and recognize the importance of working together. The potential of the system has come to the attention of city staff and public decision makers, with implementation focused on individual projects. As Denver moves forward, its leaders and citizens must confront what trails planner Bob Searns referred to as the critical balance of development and conservation.

6.1.2 Relating Green Infrastructure and Physical Activity

The history and heritage surrounding the City Beautiful movement in Denver continues to influence green infrastructure perceptions and practices. Interview responses consistently reflected the influence of Denver's nineteenth century concepts for parks and open space on twenty-first century green infrastructure. Relating green space to physical activity, landscape architect Todd Johnson stated, "These notions have been around since City Beautiful and way before, so the idea of the public right of way has utilities underground and a place to stroll." The framework in the plans of Edward Rollandet (1894) and later by George Kessler combined urban form and water resources with landscape materials, and the tree-lined parkways serve as icons of urban design in Denver (Etter 2007). Landscape architect Saco de Boer proposed tree-lined boulevards throughout the city in the 1920s, reiterating a theme that was later adopted in Denver's *Streetscape Design Manual* (1993). *The Game Plan* (2003) refers to the importance of tree canopy to provide shade to enhance walkability. *Greenprint Denver* (2006) describes walkability in terms of canopy of street trees to establish a network of public spaces for residents to enjoy healthy ecosystems.

Landscape architect Karen Grote summarized the relationship between green space and physical activity as one where various components "share the facility." The influence, however, has not been viewed as entirely positive. The challenge of maintaining ornamental green space in a semi-arid climate was cited as one that perpetuates difficulties for parks and recreation staff (Tabor 2014). While controversy has spread around responsibilities and funding for maintaining green infrastructure in Denver, the importance of the relationship between green space and physical activity has been shared across disciplines.

Respondents consistently made a positive association between green infrastructure and physical activity. "They both contribute to the same result. The infrastructure connectivity, the nature of separated sidewalks, safe bike paths and things like that contribute to people's willingness to do that" (Gordon 2014). Green infrastructure contributes to a safe inviting place for people to recreate (McConlogue 2014), and Denver Public Health related the connection and accessibility to a system for physical activity in a recent Community Transformation Grant (CTG) (Wierczorek 2014). Funding opportunities introduced the opportunity for successful collaboration among departments to advocate physical activity.

Municipal plans addressed walkability as trail connectivity shown on the parks network plan. "We look at how we can get the maximum benefit from park spaces with multiple kinds of improvements, or improvements that would allow multiple uses" (Tabor 2014). From this information, designers consider a full range and compliment of activities within a designated space.

6.1.3 Public Health Considerations

Although Denver Environmental Health participated in the development of the four municipal plans evaluated, health was addressed in a general sense. Steve Gordon, Denver Planning and Development, acknowledged that public health has been broadly addressed in planning efforts in recent years. From a design standpoint, most interaction between the parks department and the health department historically focused on the mitigation of hazards caused by previous land practices (Tabor 2014). Recently, public health grants such as CTG, have placed emphasis on obesity awareness and prevention, contributing funds for park development (Wierczorek 2014). Both the parks and public health agency interview participants commented on the value of partnerships, such as those with the Trust for Public Land and the Urban Land Institute, as sources for funding projects (Tabor 2014; McConlogue 2014). Public health staff cited support within the department for obesity prevention initiatives in collaboration with other public health directors in the metropolitan area.

Two public health agencies provide services in Denver: Denver Public Health and Denver Environmental Health, with overlapping responsibilities related to physical activity. Denver Environmental Health manages the Healthy Eating Active Living (HEAL) Program; Denver Public Health addresses programs such as Safe Routes to School. In 2012, both agencies collaborated on a Community Health Improvement Plan,[51] with a mission to improve health at the community level. The purpose of the initiative is two fold: 1) Access to care, including behavioral health, and 2) promotion of the HEAL program.

While strides have been made in recent years toward health promotion and physical activity, in plans such as *Denver Moves* (2011), concerns endure regarding Denver's advocacy of physical activity. Interview discussions suggest inadequate emphasis placed on health at the city level, with promotion left to non-profit organizations such as the Colorado Health Foundation.

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[51] www.BeHealthyDenver.org

6.1.4 Power and Collaboration

Policies support green infrastructure and physical activity, yet challenges exist in code requirements to implement policy objectives. From the perspective of one landscape architect, a broader level of understanding at policy level of more aggressive initiatives breaks down at the staff level. A developer's representative expressed similar sentiments, "The code book has nothing to support policies. All those things have to align" (Andrews 2013). This may be attributed in part, to a time lag between promulgation of policies and adoption of rules and regulations. The objectives envisioned in policies often take years to be documented in code requirements. The street design guidelines illustrate the dilemma, "Regulations don't adequately deal with potential for incorporating stormwater [in planted areas]" (Gordon 2014). Policies have been developed to promote green infrastructure in municipal plans, and Denver's *Water Quality Management Plan* (2004) delineates best management plans for implementing green infrastructure solutions. The *Streetscape Design Manual* (1993) was last updated in 1997 (Gordon 2014), and therefore, does not reflect policy goals. To further complicate the issue, design guidelines and standards are often established through the planning approval process.[52] Area plans such as those for Lowry and Stapleton delineate specific guidelines. Although Denver has changed policies as recently as 2013 to support green infrastructure, there is no credit for stormwater treatment for porous pavement (Wenk 2013). Further complicating the ability to track such information, strategic plans and technical manuals are not typically appended to comprehensive plans.

Departmental silos challenge goals for multi-functional green infrastructure. Identifying barriers for advancing a holistic and multi-functional approach to green infrastructure, some respondents alluded to the institutional structure and goals of

[52] www.denvergov.org

different departments. One planning consultant lamented, "Departments are all still so silo based." Mark Tabor, Denver Parks and Recreation, described the frustration with large multi-departmental initiatives, "It gets crazy because the complexity and the missions of the various city departments, they are pretty myopic in their mission; collaboration is a lot harder than just being focused your objectives." Another consultant offered, "It comes down to who's got the money and who's go the power…most departments don't work well together. They really don't." Departmental boundary lines are artificial (Wenk 2013), impacting natural boundaries of ecosystems.

Successful collaboration centers on a common interest. One landscape architect stated, "If there's not a common interest, collaboration is very difficult if not impossible." Articulating the value of shared interests between green infrastructure and physical activity, landscape architect William Wenk described multi-functionality: "They do multiple things…most infrastructures historically have been designed to do one thing, at least post World War II. We design a road to carry cars, a park to throw a baseball, and the more layers of use you can get out of that, the more value it has." These multiple functions are contested in terms of compatibility with respective uses, such as parks. Discussion of successful alliances addressed problems bound by common interests across departments, particularly those armed with adequate resources to bring projects to fruition.

Recommendations for future collaboration varied among key participants. Acknowledging the broad scope of duties charged to city planning staff, Steve Gordon emphasized priority projects kept "front and center" to apply more consistent efforts. Participants made reference to projects that lost momentum and focus due to project delays, ensuing greater expenditure of resources (Gordon 2014; Searns 2014). Another recommendation called for projects shared among departments to encourage collaboration. “If there’s a common interest, collaboration can occur. [We] need to have a problem to solve, like when public works needs help on a functional sustainable landscape” (Tabor 2014).

6.1.5 Measurement

Based on interview data, there were mixed reactions as to what should be measured. Responses ranged from a lack of involvement or interest in measurement, to budget implications of highly used green infrastructure systems, to specific measurements of demographics and monitoring of population health impacts such as physical activity and Body Mass Index (BMI). One respondent expressed frustration with performance of green infrastructure, noting, “We don’t really know how performance works; we may have established metrics, but they may not be the right ones.” Most agreed on the importance of the replicability of a project’s best practices. One planner stated that a successful application forms the basis for replication, while another stressed the importance of principles of creating planned communities that had been used elsewhere, with fundamental planning principles adapted to each site.

In addition to the range of responses, issues with collection and availability of data persist at the local scale. The *Health of Denver Plan* (2011) states that a lack of data exists to evaluate the built environment, compounded by the difficulty of measuring abstract concepts such as social cohesion and perception of safety (2011, 39). Advocating use of green infrastructure on future projects, cost effectiveness was mentioned as a critical indicator.

Municipal plan goals seem arbitrary without methods to assess them. Goals for tree canopy coverage in the city are addressed in both *The Game Plan* (2003) and

Greenprint Denver (2006). The objective seeks to increase the city's tree canopy from six percent to eighteen percent, without justification for such an increase or any empirical evidence to support the objective.

6.2 Lowry: Signature Project Findings

Development themes in the *Lowry Reuse Plan* (1993) included an open space system that integrated existing and proposed facilities, in an effort to optimize the value of multiple uses. The reconfiguration of the base golf course, renamed 'CommonGround Golf Course,' contributed to the network of recreation and open space on site. Spatial organization focused on daylighting a segment of Westerly Creek through Lowry, previously piped underground for stormwater management purposes. This presented the opportunity to integrate a regional flood control area, bounded on site by existing Westerly Creek Dam on the southern portion of the site, and Kelley Dam at Lowry's northern terminus. The centrally located regional scale amenity provides multiple benefits–stormwater management, conservation, and recreation. It serves as a major contribution not only to Lowry open space network; along with supporting neighborhood parks for the development, it substantially increased parkland acreage in Denver.

Plans consistently emphasized connectivity both on site and to adjacent destinations throughout the evolution of the Lowry community. A chapter in the *Lowry Reuse Plan* devoted to urban design portrayed goals and strategies for connectivity and cohesion, later supported by the Lowry community guidelines and review process outlined therein. Recommendations issued for subsequent phases of development reiterate original goals. Pedestrian and bicycle circulation onsite illustrate a thoughtful execution of a well-documented plan. Connections to off site destinations included in plans, however, have not yet been fully realized. More importantly, a disconnect lies between policies and codes posing major barriers to intended development relative to green infrastructure.

6.2.1 Green Infrastructure at Lowry

Emphasis on development at the time of the project was not specifically tailored to promoting green infrastructure. According to Todd Johnson, one of the project team's landscape architects, "Back in our day it was cutting edge just to clean up the site." The foundation of the environmental commitment at Lowry rested in mediation of contaminants from previous land practices. Nonetheless, green infrastructure was incorporated on site, employing conventional strategies. Bill Wenk, project landscape architect for the regional park facilities, described the approach as "pretty simplistic." Westerly Creek and the Great Lawn Park function as regional detention for stormwater and water quality treatment for several large outfalls. The Westerly Creek Dam area contains approximately 100 acres (40 hectares) of wetland plant materials, for water quality treatment and habitat enhancement. Daylighting Westerly Creek between Kelley Dam and Westerly Creek Dam created a naturalized corridor to link wildlife habitats. Restructured rubble placed at Westerly Creek Dam allows trail access to the top of the 45-foot (13.7 meters) dam, providing scenic views to downtown Denver and the Front Range of the Rocky Mountains (Grote et al. 2014). The primary function was a dam to control a 500-year storm event; a secondary function turned the rising slope into a walkway (Wenk, 2013).

The Great Lawn Park, a 50-acre (20 hectares) site along Westerly Creek in the central portion of the project, experienced delays due to the discovery of additional environmental contaminants, and the design of the park had to be reconfigured. With thirty-five percent of total park area established with native plants and grasses, Mark Tabor credits the design for shifting user expectations of parks in Denver, “They did a great job and really moved the ball ahead in terms of plant palette and irrigation.” Similar to Great Lawn Park, other large parks at Lowry function as multi-functional landscapes, retaining stormwater runoff onsite (Grote 2014). The aggregation of stormwater management in the site’s common areas facilitated a compact configuration of development parcels for both residential and commercial land uses.

Chapter Four of the *Lowry Reuse Plan* (1993) prescribed the urban design framework for Lowry as a key element in the development plan–outlining organization, identity, character, and purpose. The plan identified destination locations in the city with relationship to Lowry. Several of these areas were later identified in Denver comprehensive planning documents as “areas of change,” targeted for growth and development (City and County of Denver 2000; 2002). Urban design goals included: onsite flood control linked to parks, as well as regional, community, and neighborhood open spaces; major street design to reflect the character of Denver’s historic Sixth Avenue parkway,

Figure 6.1 Sixth Avenue streetscape at Lowry

a major entrance to Lowry; primary and secondary open space systems; and special consideration to eliminate or mitigate negative visual impacts, such as parking. Selection of thematic streetscape elements contributed to the urban design vocabulary for the project, clearly identifying a series of paths and edges. According to project engineer Dennis Arbogast, the consultant team spent considerable time working with the city and negotiating [amenities that are attractive and promote green infrastructure]. The articulation of multiple uses within open space was a development goal at Lowry, but it had not been widely endorsed by the city of Denver.

6.2.2 Challenges to Multi-Phased Development

Development at Lowry was complicated by three major factors that impacted both site configuration and the approval process. The first involved Public Benefit Conveyance (PBC), making surplus federal property available at little or no cost for public uses such as education, health care, recreation, housing, and health care (Stern 2006). The LRA had to work with what property remained, planning around the PBC parcels. Secondly, the magnitude of a significant infill project overwhelmed city departments charged with development review and permitting. Denver had not experienced large-scale development in the city for several years preceding Lowry, and was not organized to accommodate LRA's fast track approach to infrastructure implementation. This became a monumental task given that existing infrastructure was inadequate and did not meet local code requirements. A city staff person was appointed from the Mayor's office to act as a liaison between LRA projects and city departments, and specific staff members were assigned to Lowry projects (Arbogast 2013). Another limitation centered on the groundwater contamination resulting from solvents used to degrease engines (Stern 2006; Wenk 2013; Arbogast 2013). Concentrated in the Great Lawn Park area, major plan revisions and remediation activities influenced reconfiguration of the major open space network.

One advantage to multiple project phases was the ability to apply lessons learned in earlier phases. According to Alan Ward, Sasaki Associates' project principal and planner for the Lowry master plan, the spatial configuration and function of water was a key issue in the conceptual development of the plan. Todd Johnson of Design Workshop explained the evaluation of water to guide specific strategies employed in design in terms of movement, containment, and quality enhancements. The master planning of infrastructure resulted in construction of a network of aggregated infrastructure during initial stages of development. Other strategies, such as narrower streets, were more readily adopted in later phases of development. Reflecting on the project's evolution through multiple phases Ward stated, "We probably would have treated some of these [original concepts] differently in more recent years." The luxury afforded by multiple phases served as a means to apply lessons learned.

6.2.3 Site Audits: Evaluating Multi-Functionality and Connectivity

On site evaluation and audits at Lowry were conducted September 25–29, 2014. CfAD *Urban Design Checklist* was used to identify major design features in the development, with particular attention given to connectivity within the project and to adjacent sites as identified in the Lowry Reuse and General Development Plans. The Physical Design Strategies checklist served as a tool to assess the presence of physical design characteristics and corresponding green infrastructure elements for six Lowry park sites, representative of the character and facilities for regional, community, and neighborhood parks. Table 6.2 illustrates the results of the CfAD Audit.

Table 6.2 Lowry CfAD Audit

CENTER FOR ACTIVE DESIGN

LOWRY DENVER SITE AUDIT and EVALUATION
September 25 - 29, 2014

CHECKLIST URBAN DESIGN

● Indicates Item addressed or present on site.
Additional comments are shown in italics.

2.1 LAND USE MIX

● When Planning for urban scale developments, provide for a mix of uses - for example, residences, offices, schools, retail stores, cultural and community spaces, and recreational facilities.

● Locate places of residence and work near destinations such as parks, walking paths, trails and waterfront recreation areas.

● Develop supermarkets and full service grocery stores near places of work and residence.

2.2 TRANSIT AND PARKING

● Locate buildings and building entrances near public transit stops and along transit corridors.

● Place public transit stops along well-connected streets.*Bus stops on major streets*

○ Provide signage at buildings, transit stops, and major intersections showing a map and the distance, time, route and calories burned to the nearest or next transit stop. **Inadequate signage for pedestrians*

○ Encourage transit use by furnishing transit stops with pedestrian conveniences.**Inconsistent*

● Make sidewalks wide enough to comfortably accommodate pedestrians, including those with disabilities **Sidewalk widths vary. 5' minimum sidewalk width on neighborhood streets.*

● Provide additional space for passengers to wait by adding bus bulbs.

□ Create bus stop shelters that protect the users from sun, wind, and rain **Inadequate shelter*

□ Furnish bus stop shelters with seating or places to lean. ** Not on all stops*

● When designing sites that include parking, consider how the provision of parking can affect the use of more active modes of travel such as walking, bicycling, and public transit.

● Provide parking for people with disabilities

2.3 PARKS, OPEN SPACES, AND RECREATIONAL FACILITIES

● Design open spaces as part of large -scale developments, or locate buildings near open, public spaces.

● Make bicycle and pedestrian routes to parks and public spaces safe and visible. **bike routes have few signs.*

● When planning a new development. Aggregate open space in one large area rather than dispersing into smaller pieces. Where possible, provide residents with access to open space within a ten-minute walk.

● In the design of parks or open spaces, provide paths, running tracks, playgrounds, sport courts, and drinking fountains. **not all drinking fountains were 100% operational at time of evaluation.*

● Locate new projects near existing public and private recreational facilities and encourage development of new facilities, including indoor activity spaces.

● When designing offices and commercial spaces, provide exercise facilities or walking paths nearby.

● Design parks, open spaces, and recreational facilities to complement the cultural preferences of the local population, and to accommodate a range of age groups.

● Create partnerships with organizations to sponsor and maintain green spaces and gardens.

2.4 CHILDREN'S PLAY AREAS

CENTER FOR ACTIVE DESIGN

LOWRY DENVER SITE AUDIT and EVALUATION
September 25-29, 2015, continued

- ● Design courtyards, gardens, terraces, and roofs that can serve as outdoor spaces for children's play
  **No terraces or roofs observed as outdoor spaces for children's play; courtyards and gardens are present.*
- ○ When designing playgrounds, include ground markings indicating dedicated areas for sports and multiple use.
- ○ Preserve or create natural terrain in children's outdoor areas.
- ● Provide lights on sidewalks and active play areas to extend opportunities for physical activity into the evening.
- ● In the design of parks and playgrounds, create a variety of climate environments to facilitate activity in different seasons and weather conditions.
- ○ Provide physical activity facilities for children and youth in schools **school open space not evaluated*
- ○ Design new school physical activity facilities to potentially allow for public use outside of school hours.
  **not applicable*

2.5 PUBLIC PLAZAS

- ● Create attractive plaza spaces that are well-maintained.
- ● Locate public plazas along popular pedestrian streets.
- ○ Locate plazas near transit stops.
- ● Make plazas accessible to bicyclists.
- ● Create plazas that are level with the sidewalk.
- ● Design plazas that allow for diverse functions
- ○ Design plazas to accommodate use in a variety of weather conditions. **variety of weather conditions not observed*
- ○ Seek partnerships with community groups to maintain and program plazas. **not applicable*

2.6 GROCERY STORES AND FRESH PRODUCE ACCESS

- ○ Develop full-service grocery stores within walking distance in all residential neighborhoods. **not measured from all areas*
- ● Introduce farmer's markets as a complement to grocery stores.
- ● Provide safe walking and bicycle paths between densely populated areas and grocery stores and farmer's market sites.
- ● Design grocery store layouts and parking to accommodate pedestrian, cyclist, automobiles, and loading trucks safely and conveniently. Provide infrastructure such as bicycle parking a drinking fountains.
  **While accomodations are made for pedestrians and bicycles, preference and convenience is given to automobile traffic and parking.*

2.7 STREET CONNECTIVITY

- ● In large-scale developments. Design well-connected streets with sidewalks and keep block sizes relatively small.
- ○ Where current connectivity of sidewalks and streets on a building site is poor, provide pedestrian paths through existing blocks. **Pedestrian paths well connected through existing blocks as executed from original design plan.*
  Avoid creating pedestrian over- and underpasses that force walkers to change levels.
- ○ Maintain dedicated pedestrian and bicycle paths on dead-end streets to provide access even where cars cannot pass. **Not applicable*
- ● Minimize addition of mid-block vehicular curb cuts on streets with heavy foot traffic.
- ● Design vehicular driveways and ramps to minimize contact between cars and pedestrians. **Use of alleys minimizes curb cuts along street network sidewalks.*

2.8 TRAFFIC CALMING

- ● Design roads to be minimum width and to have the minimum number of lanes practical.
- ● Incorporate traffic calming street additions such as curb extensions, medians, and raised speed reducers.
- ○ Consider other physical design measures where appropriate, for example:
  □Horizontal deflections such as curved roadway alignments 'Vertical deflections such as raised intersections or crossings
  ● Traffic diverters, roundabouts, and mini-traffic circles

CENTER FOR ACTIVE DESIGN

LOWRY DENVER SITE AUDIT and EVALUATION
September 25 - May 29, 2014, continued

□Signal phasing plan with a protected left-turning lag phase
□"Yield to Pedestrian" signs
□Avoidance of slip lanes and wide curb radii

2.9 DESIGNING PEDESTRIAN PATHWAYS

● Create a buffer to separate pedestrians from moving vehicles using street furniture, trees, and other sidewalk infrastructure. **effective use of tree yard to separate vehicle lanes from walkways*
● Provide seating, drinking fountains, restrooms, and other infrastructure that support increased frequency and duration of walking. ** seating provided in high use areas , plazas and parks; not all drinking fountains opeational at time of evaluation*
● Provide exterior lighting along streets and outdoors paths. **street lights, and path lighting in Great Lawn Park*
● Include trees and objects of visual interest on streets and sidewalks.
● Make sidewalk widths consistent with their use.
○ Provide for enhanced pedestrian crossings both at mid-block and at intersections.
● Construct curb extensions along sections of the sidewalk that tend to attract greater pedestrian congestion. **at Sports Park.*
● Create or orient paths and sidewalks toward interesting views.
○ Provide marked, measured walking paths on sites as part of a way finding system targeted to pedestrians and bicyclists. **no distance markers or interval signage observed.*
● Make streets and paths universally accessible. Create:
□Paths that are smooth, sufficiently wide, and that have curb cuts and turning radii adequate for a wheelchair or walker.
●Paths with auditory crossing signals, adequate crossing time, clear signage , visible access ramps, and connections to walking, cycling and public transit routes.

2.10 PROGRAMMING STREETSCAPES

● Incorporate temporary and permanent public art installations into the streetscape.
● Organize pedestrian-oriented programs, such as charity walks and vehicular street closures, that make wide avenues available for walking and bicycling.
○ Increase the number of outdoor cafes to enhance street activity.

2.11 BICYCLE NETWORKS AND CONNECTIVITY

● Design interconnected bikeways and establish a backbone network of unbroken through routes.
○ Make links between bicycling and transit. **not evident at time of site observation*
○ On bikeways, include signposts providing bicyclists with directions, distances, and times to various destinations. **city route numbers identified, no directions or distances and times to destinations found.*

2.12 BIKEWAYS

○ Use on-street markings or signage to visually reinforce the separation of areas for bicyclists and motorists.
● Where conditions warrant, separate bikeways and vehicular traffic lanes with physical demarcations.
○ Expand existing bikeways where use has exceeded capacity
○ Pay special attention to the treatment of bikeways at intersections and other points where the street form changes, in order to mitigate potential visibility issues and turning conflicts.
○ Avoid potential conflicts between cyclists and opening car doors - for example, by widening parking lanes where appropriate.
● Further develop Greenways - alternate routes that are integrated into the regional park system. **throughout Westerly Creek corridor and connecting to sidewalk system .*
● Consider shared-use paths in areas with viewing attractions.

2.13 BICYCLING INFRASTRUCTURE

● Provide adequate facilities for bicyclists to park along their route or at a final destination.

Lowry CfAD Audit, continued

CENTER FOR ACTIVE DESIGN

LOWRY DENVER SITE AUDIT and EVALUATION
September 25 - May 29, 2014, continued

- ◯ Designate bicycle-specific crossings and signals to organize the movements of pedestrians, cyclists, and motorists at busy intersections.
- ◯ Construct bicycle share programs to increase access to bicycles for both city residents and visitors.
  **bike share not observed onsite.*

Lowry Denver *Page 4 of 4*

Site evaluation strongly suggests that Lowry met its design goals for development in the integration of open space and infrastructure systems. Although green infrastructure implementation was considered conventional by current practices, it successfully integrated stormwater management and recreation in its open space network. Prior to realizing the desired outcome, oppositional perspectives had to be resolved. According to LRA Director Monty Force, “Authority in the parks department envisioned [Westerly Creek] as a park system, and the Denver Wastewater Department viewed it as a stormwater conveyance and those two visions didn’t align themselves.”

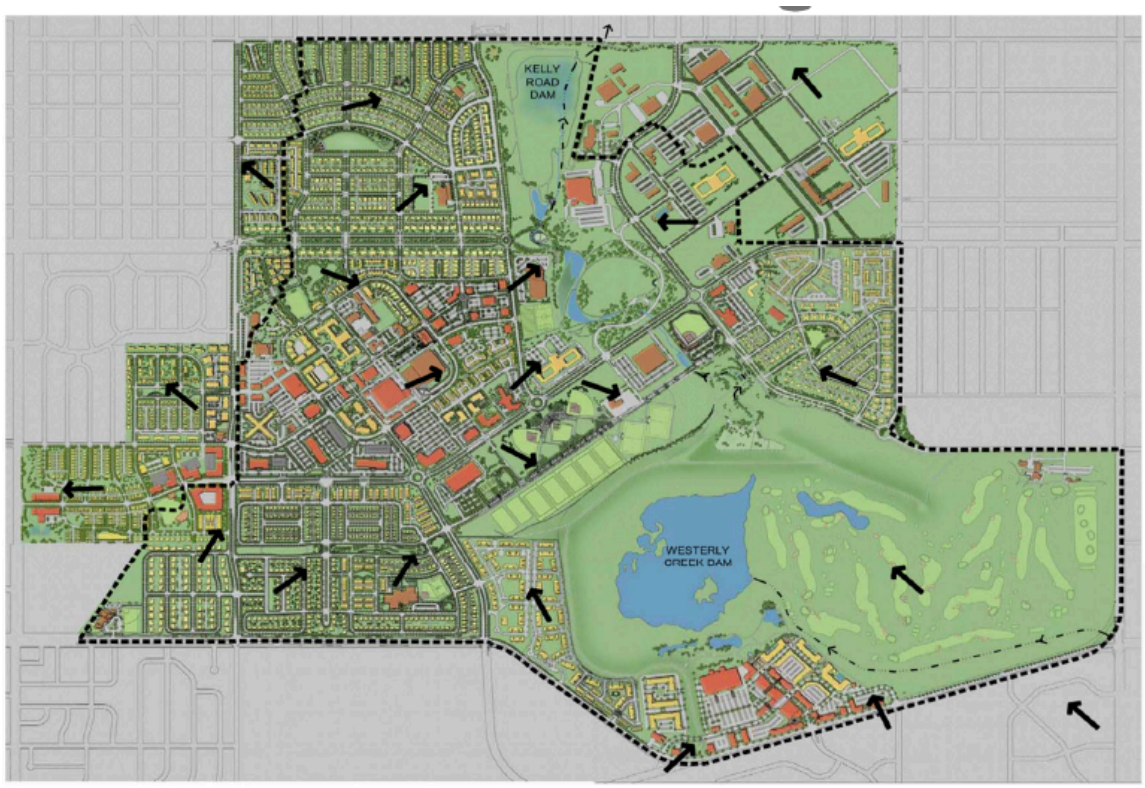

Figure 6.2 Lowry Illustrative Stormwater Master Plan (source: Lowry Redevelopment Authority, Denver)

Integrating the two systems enabled Westerly Creek to link Lowry’s parks with different purposes, functions, and visual character.

Lowry’s pedestrian and bicycle circulation routes are complete and well-connected, but signage remains largely autocentric. Sidewalk widths vary from five to twelve feet aligned with the street hierarchy, with relatively small block sizes. A secondary system of walkways joins sidewalks to off-street destinations. Alleys were constructed throughout the development, minimizing the number of curb cuts for driveway entrances and grade changes on sidewalks. The trail system extends in a north-south direction through the central portion of the property along Westerly Creek, intersecting with an east-west twelve foot wide multi-use trail along Lowry Boulevard. Shared routes lack directional signage, and identification of bicycle circulation is limited to city designated route markers. As much as Lowry has been thoughtfully planned and well-executed in terms of meeting its original goals, signage and directional wayfinding tends to favor motorized vehicles.

Most of the walkways throughout the community are classified as detached sidewalks, separated from the roadway curb by a six to eight foot wide planting area referred to as a ‘tree lawn.’ Tree lawns at Lowry are typically planted in turfgrass, with a mixture of native and ornamental street trees at varying intervals to provide shade.

Buildings and building entrances appear to be within a reasonable proximity of public transit stops. Transit stops are located throughout the development, yet use and location of shelters is inconsistent.

Figure 6.3 Bus stop without shelter

Figure 6.4 Bus stop with shelter

Pedestrian connections to off site destinations faced significant challenges. Lowry Air Force Base was a largely self-contained community with controlled access. The city street system at Lowry did not tie into the city's street system, with the exception of major controlled access points. At the time of its closing, the proposed development faced a well organized opposition to change from adjacent neighborhoods (Ward 2013). Connections to onsite open space and parks worked into the lengthy public involvement process undertaken as a part of the project. A planned trail system extends from Lowry's northern boundary along Westerly Creek to Stapleton, and southward to Highline Canal, a regional corridor "being actively worked on to make that connection an reality" (Wenk 2013). The property is completely bounded by public rights of way, with observed high volumes of traffic on major arterial routes.

While there are several crosswalks along the project periphery, two issues continue to challenge pedestrian connectivity. One is that of the configuration of adjacent parcels, where many of the residences do not face the major collector roads around Lowry. In other words, the Lowry property was a 'back door' to adjacent developments as there was purposefully no reason to connect.

Figure 6.5 Configuration of adjacent properties at Lowry

Figure 6.6 Major arterials encompass Lowry property

Secondly, existing cross walks at main arterials such as Alameda Avenue and Havana Street, may challenge perceptions of comfort and safety for pedestrians traversing several lanes of traffic.

Connectivity and legibility was also observed and evaluated for the parks in the Physical Design strategy design inventory. The evaluation showed most strategies evident within Lowry in terms of access, comfort and safety, and active engagement. Deficiencies were observed in proximity and locations of restrooms, and no trails or walkways were marked for distances travelled.

Table 6.3 Physical Design Strategies Audit for Lowry

Inventory: Physical Design Strategies on Case Study Projects

Lowry Denver

Conducted September 25 - 29, 2014

●	Indicates item is present on site
◐	Indicates some items present or item not adequately represented on site
n/a	Indicates item not applicable to specific site
	Indicates item not present

		Park Location					
		Great Lawn	Crescent	City of U.	Libeartor	Mustang	Tailwind
Access							
Legibility	Ease of movement throughout activity areas in the park	●	●	●	●	●	●
	Clearly visible and multiple access modes to the park	●	●	●	●	●	●
	Respectful of terrain	●	●	●	●	●	●
Coherence	Separation of Traffic Modes - car, bicycle, pedestrians, transit				n/a	n/a	n/a
	Aggregation of open space in large central area	●	●	●	●	●	●
Tidiness	Trails with good surfaces	●	●	●	●	●	●
	Provision for areas made for sun in winter, shade in summer	●	●	●		●	●
Connectivity	Trail connections to offsite trails and parks	●	●	●	●	●	●
Context	Neighborhood access encourages park use	●	●	●	●	●	●
Comfort and Safety							
Legibility	Safe and visible pedestrian and bicycle routes within the park		●	●	◐	◐	●
	Benches	●	●	●	●	●	●
	Restrooms - location and proximity to use areas	●	●				
	Drinking Fountains - location and proximity to use areas						
Coherence	Lighting on Trails and Activity Areas for Extended Use	●		●			
Complexity	Effective Use of Native Materials, establishment of identity	●	●	●	●	●	●
Tidiness	Condition of Facilities and Equipment	●	●	●	●	●	●
	Little or no evidence of debris, litter	●	●	●	●		●
Active Engagement							
Legibility	Centrally visible activity spaces	●	●	●	●	●	●
	CONTEXT, proper orientation for sports courts, etc.	n/a	n/a	n/a	n/a	n/a	n/a
Context	Location of park relative to other existing public/or private facilities (co-located for shared resources)	●		●			
Diversity	Multiple facility types and uses provided	◐	◐	●	●	●	●
	Flexible Open Space Provided	●	●	●	●	●	●
Complexity	Facilities co-located to optimize simultaneous p/c activities	●	●				
	Motivational decision prompts placed to encourage mobility	●	●	●			
	Curvilinear roads and paths	●	●	●	●		
Connectivity	Connection to multi-use paths	●		●	◐	◐	◐
	Marked distance trails						
Discovery/Fun							
	Different Experiences created for road and path users	●	n/a	◐	n/a	n/a	
	Create or preserve natural terrain in children's play areas						●
Green Infrastructure Elements/lands							
Park		●	●	●	●	●	●
Open Space		●	●	●	●	●	●
Stormwater Management Areas		●	●	●	●	●	●
Street Trees/street right of way			●	●	●		●
conservation area/native grasses		●	●				
other							
urban agriculture/fruit trees							
native prairie habitat							

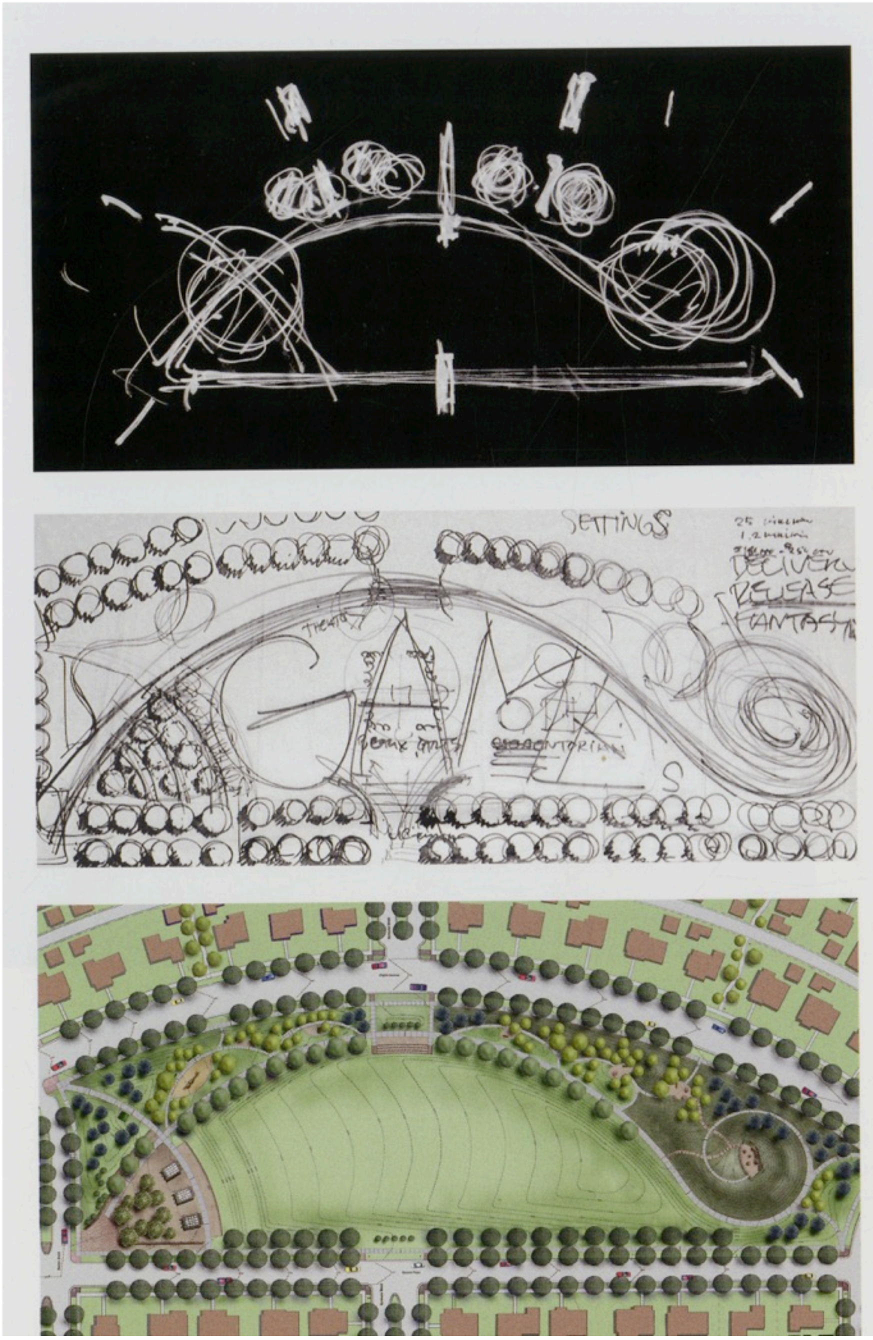

Figure 6.7 Design diagram: Crescent Park (source: Design Workshop, Denver)

Multiple access points typify access to neighborhood parks for pedestrians. This was enhanced by the strategic location of parks within Lowry's neighborhood centers. The paths and edges proposed in the Urban Design Chapter of the Lowry Reuse Plan were fulfilled in project design and implementation. Through a series of diagrams, Figure 6.7 illustrates strategies employed in the evolution of Crescent Park, an eight acre (3.2 hectares) site located in the northeast quadrant of the community.

Figure 6.8 Crescent Park multiple access points

6.2.4 Public Health Considerations

From a design standpoint, most interaction with the health department addressed environmental health in the mitigation of hazards caused by previous land practices.

According to Mark Tabor of the Denver Parks and Recreation Department, the trend has shifted in recent years to address obesity prevention and physical activity; most interaction with the health department at that time Lowry was developed had been in the mitigation of hazards resulting from previous land use practices. For example, environmental constraints prohibited construction of a pond near Sixth Avenue, and discovery of asbestos on Ulaanbaatar Park halted site work on the project until remediation was completed (Grote 2014). Other key participants concurred that consideration of public health coincided with timing of the project. One landscape architect stated, "We didn't really ask about health 15 years ago," instead expressing design objectives in terms of exercise. The focus then was one of land reuse, so public health had not been considered to be a driving force in the project (Gordon 2014). The desire for walkable neighborhoods was well documented in the planning of the project, but only referenced briefly as a health objective in the Reuse Plan (1993).

6.2.5 Power and Collaboration

At the municipal scale, policy language embraces a vision of healthy growth and quality infrastructure. Conversely, there is the reality of getting projects approved. As one development planner lamented, the real issues emerge "when the rubber meets the road."

Denver had seen scant mixed use development activity the magnitude of Lowry, with most occurring "a few acres at a time" (Force 2014). The impact of the master planned community overwhelmed the municipal regulatory system (Stern 2006) According to former LRA director Tom Markham, "We had to write the book on how to do it in Denver" (Stern 2006). The *Design Guidelines for the Lowry Community* (2003) recognized potential differences with regulations of governing body, acknowledging that conflicts may be encountered: “In such a situation, the more stringent or more restrictive standard shall apply.” Conflicts between municipal agencies and the developer resulted in project delays, with innovation testing the rules within Denver’s regulatory framework.

Major challenges faced by the design team included difficulty in obtaining approval for narrower rights-of-way in both street widths and alleys, using porous pavement for streets to facilitate stormwater runoff, negotiating design proposals through differing perceptions of stormwater management areas, and creatively addressing strategies limited by maintenance equipment and division of responsibilities.

Monty Force, LRA director, recapped his frustrations with regulations, “It would have been nice to have a little bit more control over the some of the standards and requirements. We didn’t and we had to follow all the city requirements which were geared toward a city that wasn’t growing.” In adopting a ‘road diet’ for narrower streets and alleys, resistance from the public works department became a driving force. The horizontal distance setbacks required between water and sewer lines within the right of way, dimensions for fire truck access dictated the pavement widths of streets. Precedents in the urban core hampered progress, where 28-foot (8.5 meters) wide streets with parking on both sides obstructed fire emergency access (Force 2014). Those dimensions were revisited, and through an arduous process, the city adopted a narrower street section. Project engineer Dennis Arbogast concurred, “we fought for about a year and a half to reduce the city local street standard from 32 to 30 feet [9.75 to 9.14 meters], which sounded like a small gain.” The move reflected a change in standard to promote community rather than move automobile traffic. In this regard, Lowry set new precedence to be used later at nearby Stapleton.

Porous pavement was proposed for use at Lowry in anticipation of receiving credit for stormwater management water quality treatment (Andrews 2013; Johnson 2013). Direction from city staff, however, was not clear in interpreting the requirements. Accepting the dilemma, Mark Tabor stated, "The regulators are stuck in a literal interpretation of what the standards are and sometimes lose the larger picture of how you could reach that objective." Even when staff acknowledges innovative strategies and shares the goals and visions for the project, former LRA representative David Andrews elaborated, "The staff doesn't have the empowerment to change the code book." The perception shared among participants involved in that aspect of the project was that even when the city would let you try new strategies, if it was not successful, the developer was responsible for fixing it, with no responsibility assumed by the city.

In spite of the challenges, participants recognized a spirit of collaboration. In a project the magnitude Lowry, specific city staff members were assigned to project review, and working on such a high profile project gave consultants "access to anyone in the city" (Arbogast 2013). Todd Johnson offered, "We've been effective when we've been able to create enthusiasm, support and excitement among [those involved]. We have been successful when we've been able to get at [both] the executive level [and] at the department level." At times, differing approaches to green infrastructure for stormwater management and open space escalated to a level where resolution could be reached (Force 2014). Lowry has been identified as a project throughout Denver's municipal plans as a project demonstrating sustainable development, and as a model of base reuse. Critical to its success was the emphasis placed on maintenance of the open space system.

6.2.6 The Politics of Maintenance

Lowry developed a new model for maintenance of its parks and open space. The city of Denver and the Lowry Community Master Association (LCMA) share responsibilities at Lowry. The LCMA was established as a non-profit corporation in 2007 to operate and manage common areas for "the purposes of enhancing and preserving the value of the property."[53] Denver Parks and Recreation maintains the larger parks, and LCMA takes care of parks less than eight acres (3.2 hectares) (Tabor 2014; Force 2014). In response to intensive maintenance practices from the manicured lawn appearance influenced the City Beautiful movement, Lowry parks utilized a mixture of native plants and grasses with manicured lawn areas. Differences in color and texture clearly distinguish use areas.

Figure 6.9 Park area combines native grasses with turf to reduce maintenance

[53] www.lowrydenver.com

Problems arose between Lowry and the city on maintenance practices. Discussing the significance of the project, Monty Force surmised, “For the most part, maintenance trumps anything else.” The city of Denver resistance was in three areas. The first was a reluctance to adopt new maintenance practices. If it was perceived that the city of Denver could maintain it in a way in which they were accustomed, there was little resistance, yet if it required differing maintenance practices, it was met with opposition (Force 2014). Secondly there was a lack of equipment and expertise to take on new practices. Because of available snow removal equipment, some of the neighborhood sidewalks were “like runways.” New equipment had to be purchased to clear snow from narrower walkways. Construction of alleys experienced similar fate. Due to the dimensions of trash collection equipment, the city required 25-foot wide (7.6 meters) concrete pavement. After building a few blocks of city standard alleys, Lowry opted for constructing private alleys, 18-foot wide (5.5 meters) asphalt maintained by the master association (Force 2014).

A third issue was attributed to the lack of resources. Denver Parks and Recreation lacked the staff and equipment to maintain the entire system. According to LRA landscape architect Karen Grote, “I knew that we had to make it work…if we didn’t cooperate with parks and parks maintenance the we wouldn’t get this stuff built.” The advantage of the planting palette and spatial arrangement of indigenous vegetation set precedence for new parks in Denver, so that not only was water conserved, the installation reflected the unique Rocky Mountain regional landscape (Tabor 2014). It also shifted user impressions of what a park should be, and the use of native and indigenous materials was used extensively at nearby Stapleton.

6.3 SUMMARY

As LRA director Monty Force quipped, “Every development is unique to its time and circumstances.” The repurposing of Lowry from a military technical training center to a mixed-use community represents one of Denver’s significant areas of change. The shared maintenance responsibilities for its extensive open space network has been replicated and expanded at nearby Stapleton. While its green infrastructure technology may be simplistic, its construction of backbone infrastructure and aggregation of open space integrates multiple uses for both recreation and stormwater management. The municipal plans support goals consistent with advocating green infrastructure, yet findings suggest successes at the project level have not yet been fully represented or replicated at the city scale. Connectivity for pedestrians and bicyclists is well thought out and complete, and effort has been made to connect to offsite destinations with varying levels of success.

Chapter Seven: Louisville–Reclaiming the Riverfront

This chapter presents findings for Louisville, Kentucky at both the municipal and project levels. Following the format established in Chapter Five, presentation of findings is generally aligned with research questions–beginning with an overview of patterns emerging from review of municipal plans and perceptions of interview respondents at the city scale: perceptions of green infrastructure, as well as how it relates to physical activity; issues of power and collaboration; and perceptions as to what items should be measured for green infrastructure that promotes physical activity. A summary of the analysis for Waterfront Park follows, integrating information obtained from site observation, site audits, and interviews of key participants.

Situated on the southern bank of the Ohio River, Louisville has depended on the river for commerce, recreation, and transportation. City founders envisioned public access to the river, yet as the city grew, industrial uses crowded the downtown waterfront. The convergence of three interstate highways in downtown Louisville resulted in a multi-layer configuration that local residents refer to as 'spaghetti junction.' Construction of an elevated section of the Interstate 64 freeway parallel to the Ohio River obstructed both visual and physical access from downtown to the waterfront. Although several plans were commissioned to address reclamation of lands adjacent to the Ohio River, the creation of the Waterfront Development Corporation (WDC) in 1986 initiated the development of Waterfront Park. Established as a quasi-governmental entity by the Kentucky Legislature, WDC was formed by the city, Jefferson County, and the state of Kentucky to develop, construct, and maintain the park.

This eighty-five acre (34 hectares) park provides an important urban green space in Louisville, reconnecting the city both visually and physically to the Ohio River.

Through a series of public forums held in 1988, citizen suggestions defined the scope of the project to include a public park (Bell 2011). The design of the park is based on a number of guiding principles, such as providing an attractive approach to the city, connecting the river and the park to the city, creating defined areas for a variety of activities, attracting a broad range of citizens, and spurring development for the downtown area (Wener et al. 2014). The point of origin for the Louisville Loop, a 100-mile (66 kilometers) multi-use trail is located in the park, and portions of the park also serve as areas for flood control.

Emergent patterns relative to the research questions centered on green infrastructure innovation and best practices on a municipal scale in response to a consent decree by the EPA, the influence of the Healthy Hometown Movement on planning and design for physical activity, and the strong central government that enables the coordination efforts in bringing projects to fruition. Three related issues receiving recent attention in Louisville permeated discussions with key interview participants. The planning and construction of the Louisville Loop, the decline in tree canopy, and the heat island effect in Louisville.

7.1 Municipal Scale Findings

Evaluation of municipal plans in Louisville included four documents: the *Cornerstone 2020* (2000) comprehensive plan, which serves as the foundation for municipal planning in Louisville; two ancillary documents to the comprehensive plan– *Ohio River Corridor Master Plan* (1996) and the *Parks and Open Space Master Plan* (1995); and the MSD *Stormwater Management Plan* (2010), which sets forth standards and guidelines for green management practices relative to surface drainage.

Policies are clearly stated throughout the plans in terms of goals and objectives. Documents within *Cornerstone 2020* cross-reference related goals and objectives, yet collaboration across city departments lack specificity for advancing policy to implementation. While Louisville planning policies are clearly articulated, there was no apparent reporting or update cycle found to assess effectiveness of achieving stated goals and objectives.

In terms of green infrastructure and physical activity, comprehensive plan documents emphasized recreation and conservation, with attention focused on greenways, open space, and public access to the Ohio River. Additional emphasis was placed on urban design and form. Plans advocated mobility for pedestrians and bicyclists through improved access and connectivity throughout the city, with critical linkages provided by the Louisville Loop, a multi-use trail that surrounds greater Louisville. Identified as one the "transformative projects" in the comprehensive plan, the Loop was envisioned not only as a perimeter trail along the Ohio River and throughout Louisville, but as a "special recreational feature which could include public art and an interpretive program designed to reveal to natural and cultural history for the county" (City of Louisville and Jefferson County 2000, 85). The Parks and Opens Space Master (1995) reiterated the need for the trail, proposing varying types of human use, including both recreation and transportation. Furthering the vision for Mayor Jerry Abramson's City of Parks Initiative in 2005, the Loop became a centerpiece to forward the expansion of parklands and environmental education (Louisville Metro Council 2013). Stormwater management plans addressed multiple landscape uses, with greenways and trails as a secondary use for lands designated for stormwater management. Table 7.1 presents a summary of municipal plan evaluation.

Table 7.1 Louisville Municipal Plan Evaluation

	Comprehensive Plan *Cornerstone 2020* (2000)	*Parks and Open Space Master Plan* (1995)	Stormwater Management Plan (2010)	Ohio River Corridor Master Plan (1996)	Comments
PLAN CONTENTS					
Authorship (all list public participation as contributing to authorship)	Not specified; plan was result of 7 years of coordination between Louisville and Jefferson County	Prepared by consultant Wallace, Roberts, and Todd (WRT), with input from Planning and Environmental Management and citizen groups	Metropolitan Sewer District (MSD); no other departments or individuals are credited as authors	Process guided by public/private partnership; plan prepared by consultant WRT	Participation of citizen groups identified in all but MSD plan
Clearly stated purpose, goals, and objectives	Plan identifies four major strategies within seven plan elements; Goals aligned with 3 state statutory required elements	Four major goals identified: well-maintained parks for resident needs; greenway corridors to protect natural resources; preserve and enhance visual quality; open space network to 'protect public health and safety'	Promotion of stormwater drainage management practices "in the context of a regional program"	Organized in three areas; specific actions initialized in policy framework, followed by plan implementation for phasing, early action plan, and identification of regulatory changes needed for scenic corridor designation and preservation	All clearly state goals and objectives
Policies related to green infrastructure	Term is not referenced in documents. References included greenways for recreation and conservation	Green infrastructure not used. Greenways for recreation and conservation; Policies linked to action focus on budget for land acquisition, park improvements, and maintenance	Multiple use: stormwater management primary, with greenways, trails for bicyclists and pedestrians	Green infrastructure term not used; Recreational greenways are referenced	Term used for stormwater and greenways and trails; greenways used to portray principles in 3 of 4 plans
Policies related to physical activity	Term is not referenced in documents. References include walkability in terms of transportation and recreation	Identification of recreation needs and service by geographic area	No specific reference to physical activity in major plan objectives	Pedestrian and bicycle access from neighborhoods to river, downtown connections to river	Related to pedestrian and bicycle activity; term not referenced throughout documents
Policies linked to specific action	Two-tiered approach for conventional zoning and from districts	Needs assessment for future land and facilities; identification of gaps in service	Action plan lists specific requirements for development within each watershed		Varies across plans

Louisville Municipal Plan Evaluation, continued

	Comprehensive Plan *Cornerstone 2020* (2000)	***Parks and Open Space Master Plan*** **(1995)**	**Stormwater Management Plan (2010)**	**Ohio River Corridor Master Plan (1996)**	**Comments**
FACT BASE AND CONTENTS					
Elements Specific to Green Infrastructure and Physical Activity	Terms not specifically referenced. Relates connectivity in special districts, such as the Waterfront Overlay District	no specific references to green infrastructure; conservation, active recreation facilities, as well as pedestrian and bicycle facilities; Mayor's Miles Program	Goals for employing green infrastructure to meet MS4 requirements		Access to facilities; connectivity; conservation; recreation; water quality requirements
Issues addressing multi-functionality and connectivity	Community design sets goals for walkable core and active pedestrian environment downtown	References continuation of Olmsted vision for interconnected open space network with multiple functions; lack of protection of stream corridors, and fragmentation of park system as 'isolated islands;' goal to connect parks and greenway system	States objectives to incorporate bicycle and pedestrian facilities connecting neighborhoods and providing pedestrian access to large basins	Focus on people and making connections: to river, each other, nature, work, with past, present, and future. Recognition of private land ownership and limitations presented for riverfront access	Accessibility and fragmentation cited as issues to be addressed
Integration of green infrastructure into plan	Not specifically	No specific references to green infrastructure fitting into infrastructure plan, except for references to multi-functionality in parks	Primarily as part of MS4 compliance	Development of greenways in the corridor	Multi-functionality for parks and greenways; secondary in stormwater management plan
PLAN PROPOSAL					
Spatial design	No maps included for plan proposal; limited to identification of Special District objectives	Maps included for stream corridor/green way plan, except references to multi-functionality in parks	Maps for watershed boundaries, action plan lists types of projects to be implemented	Replication of great lawn from Shawnee Park to Waterfront Park	
Implementation time table	No specific parameters listed.	Short, mid and long range recommendation in plan, but not specific time frame for ranges; targets active sports facilities; pedestrian and bicycle facilities categorized as 'other'	Green infrastructure to be part of MS4 requirements by 2012; consent decree requirements must be met by 2024	Phase One Completion 1996-2000; time frame not specified for other phases of development	Specific only in Stormwater Management Plan

Louisville Municipal Plan Evaluation, continued

	Comprehensive Plan *Cornerstone 2020* (June 15, 2000)	*Parks and Open Space Master Plan* (1995)	Stormwater Management Plan (August 2010)	Ohio River Corridor Master Plan (1996)	Comments
Identification of signature project in plan (Waterfront Park)	Waterfront Park Overlay District-plan states it should be represented in Land Development Code.	Waterfront Park is mentioned as one of several parks along the Ohio River. Louisville Loop, which begins in WP, is significant as a connector and perimeter trails throughout Jefferson County.	Waterfront Park is located in Ohio River/City watershed, which was not studied in detail (outside IOAP).	Activity center designated for Waterfront Park.	Mentioned across plans, but park is outside area for water quality consent decree.
Integration of green infrastructure in plan	As greenways and trails, conservation areas.	Greenways and trails.	Projects and proposals listed by watershed.	Development of greenways in the corridor.	
PLAN CONSISTENCY					
Federal and State mandates	Relates plan to state statutory requirements for comprehensive planning.	Clean Water Act-USACE for wetland protection jurisdiction.	Consent decree requirements by EPA; MS4 permits through KY Environmental and Public Protection Cabinet.	Not stated.	Varies.
Coordination with Federal/State agencies	Not specific to green infrastructure and physical activity; reference to state transportation in terms of bicycle support.	Relative to facilities in Jefferson County; State Fish and Wildlife for riparian corridor conservation and restoration plan; State transportation for bicycle plan.	Not referenced.	With USACE to develop McAlpine Locks as a visitor attraction.	
Regional coordination	Not stated.	Coordination with Indiana for connection to Ohio River Greenway.	not referenced.	Not stated.	Only in terms of Ohio River Greenway connection
Coordination among city agencies	References to Olmsted Parks and Parkways Master Plan, Jefferson County Forest, Parks and Open Space Plan, Coordination with Land Development Code requirements.	Cornerstone 2020: Flexible Form strategy; Multi-Objective Stream Corridor Greenway Plan, Environmental performance standards; Bicycle and Pedestrian Plan; Louisville Loop Plan.	With respect to meeting stormwater requirements.	Coordination and management of greenways with MSD, Parks Department; with Public Works for bicycle facilities.	Goals stated, but few methods or procedures stated.

The following sections present a discussion of major findings, first at the municipal level, followed by issues relevant to the research questions for Waterfront Park. Identification of emerging patterns integrates municipal data from plans were evaluated, with interview responses from key participants in the study. Analysis was informed by additional documentation obtained or referenced in discussions with interviewees relevant to green infrastructure and physical activity. Patterns are presented in italicized text, followed by discussion for each.

7.1.1 Perceptions and Patterns of Green Infrastructure in Louisville

Perceptions of green infrastructure varied among interview responses. One respondent noted a disconnect in the timing between municipal plans. The advancement of green technologies and green management practices were delineated in the Stormwater Management Plan (2010), but no discussion specific to green infrastructure elements and strategies was found in Cornerstone 2020 (2000). Another participant expressed a fundamental lack of understanding, stating, “I don’t think folks know what the term means.” Leann French, Louisville Public Health and Wellness, found the term limiting its potential: “[it] sounds very ‘tree-huggerish’...there’s a disconnect in understanding the importance of green infrastructure to the vibrancy of a city, to economic development and to building social capital.” One reason for the lack of understanding was attributed to few examples demonstrating green infrastructure principles particularly in outlying areas (Williams 2014). Wes Sydnor, MSD municipal engineer, cited successful examples in the central part of the city, where a partnership with the University of Louisville incorporated green infrastructure in several campus projects.

Figure 7.1 Floyd Street/Central Avenue, University of Louisville (source: QK4 Engineering, Louisville)

The EPA consent decree mandates for stormwater management highlighted an awareness of the potential of green solutions. Federal compliance has emphasized green infrastructure in Louisville. In 2005, MSD entered into a consent decree to improve stormwater water quality treatment in response to violations of the Clean Water Act. The legally binding and federally enforceable agreement–between MSD, EPA, the U.S. Department of Justice, and the Kentucky Department for Environmental Protection (KDEP)–outlines measures to resolve "alleged violations of the Clean Water Act for untreated overflows from Louisville's combined and separate sanitary sewer systems."[54] In accordance to the requirements of the consent decree, as amended in 2009, MSD

[54] http://msdprojectwin.org/

prepared the Integrated Overflow Abatement Plan (IOAP) to reduce and mitigate the effects of wet weather CSOs, eliminate SSOs and other unauthorized discharges.

According to planner Steve Sizemore, "[Federal requirements are] shifting the way design is occurring." MSD engineers now seek opportunities for green solutions that are cost effective and more aesthetically pleasing (Sydnor 2013). Stormwater is a primary focus. As a standalone special district, MSD is funded by utility rates. Therefore, the district must justify funds expended; green infrastructure projects must be in direct response to stormwater utility. Interview responses suggest the decree, however, has a more far-reaching effect in advocating green infrastructure. Gary Pepper, a landscape architect for WDC, expressed the positive influence of the MSD projects: "Everybody has bought into the idea… because it's the right thing to do." Recent efforts observed include bioswales along trails, rain gardens, and street tree planting.

Concern for heat island effects considers trees as green infrastructure for mitigation. Weighing the importance of green infrastructure initiatives, Steve Sizemore summarized community awareness about the heat island effect stemming from work conducted by Brian Stone, Director of Georgia Institute of Technology's Urban Climate Lab: "Louisville was just recognized as one of the hottest cities in the country on average temperature. And our tree canopy is low compared to a lot of cities." Stone identified Louisville among the most rapidly growing urban heat islands in the United States.[55] In response, the city commissioned a study to identify zones in the city suitable for the implementation of mitigation strategies such as tree planting, roof surfaces, and pavement treatments. Establishing an urban heat baseline, the study will be utilized to inform city policy and resource allocation.[56]

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[55] http://www.urbanclimate.gatech.edu/projectList.shtml

[56] https://louisvilleky.gov/government/sustainability/urban-heat-island-project

As a green infrastructure strategy, more trees are being planted in the community (Heitz 2014). As of 2013, however, Louisville was one of few major U.S. cities without a tree ordinance (Goodyear 2013). Mayor Fischer formed a tree commission by executive order in 2012, to inventory existing resources as well as decline in percentage of tree canopy coverage. The *Louisville Urban Tree Canopy Assessment* (Davey 2015) documented existing tree canopy by city districts, modeling projections for tree canopy goals. A draft "Louisville Metro Ordinance" was presented to city council in June 2015 (Bruggers 2015). Mike Heitz described need for the regulation "to stop the [removal] of trees and denuding sites." At the time of data collection, the city had not yet adopted an ordinance for protection and removal of trees.

7.1.2 Relating Green Infrastructure and Physical Activity

Key participants made a positive association between green infrastructure and physical activity. Bicycle coordinator Rolf Eisinger explained the association as one providing capacity for the other in that green infrastructure provides the facility necessary to participate in physical activity. Assisted in part by a Healthy Kids Healthy Community grant from the Robert Wood Johnson Foundation, bike lanes, sharrows, and marked walking paths have been implemented around the city (French 2014; Edwards 2014). Mike Heitz reiterated the relationship, stating, "Green infrastructure attracts people…if we have activities laid out for them such as walkways and playgrounds, people will use them." From a stormwater management perspective, physical activity serves an ancillary use. Proximity of parks to integrated stormwater conveyances offers the opportunity to concurrently enhance water quality and provide facilities for recreation (Sydnor 2013).

Municipal plans referenced continuation of Frederick Law Olmsted, Sr.'s vision for an interconnected open space network with multiple functions. The need to protect stream corridors and minimize the fragmentation of the park system was proposed to mitigate an assemblage of 'isolated islands.' The goal of the *Parks and Open Space Master Plan* (1995) connects the parks through a greenways system. The *Stormwater Management Plan* (2010) states objectives to incorporate bicycle and pedestrian facilities connecting neighborhoods and providing pedestrian access to large basins. The *Ohio River Corridor Master Plan* (1996) placed emphasis on people and connections to the river, noting the limitations that private land ownership presents for riverfront access.

7.1.3 Public Health Considerations

The Healthy Hometown Movement served as a catalyst to promote physical activity. Established in 2004 by former Mayor Jerry Abramson, the Mayor's Healthy Hometown Movement (MHHM) strives to create a culture of health and wellness in Louisville.[57] The program focuses on physical activity and optimal nutrition. One component of the program is the Mayor's Miles, a distance-marking system for walking paths. The paths feature ground marking signs at 1/10-mile (0.16 kilometer) intervals with the goal of facilitating walking for both individuals and groups. The program has been incorporated in parks across the city, including Waterfront Park.

Participants credited MHHM for making connections across city departments to promote physical activity. Active living comprises one of four committees facilitating collective efforts (Sizemore 2013). Collaboration among departments continues to grow since Mayor Jerry Abramson initiated MHHM as a part of his City of Parks Initiative.

[57] https://louisvilleky.gov/government/mayors-healthy-hometown-movement/

According to Metro Parks Director Mike Heitz, monthly meetings enable review of health initiatives among different departments, "It helps to have everyone under the same umbrella to interact with and communicate."

Louisville Public Health and Wellness engages other departments, partnering efforts with funding and events. The Public Health and Wellness department has been a key partner in obtaining grant funding to support physical activity in Louisville through the CDC with CTG and CPPW awards (French 2014; Sizemore 2013). Initial MHHM efforts brought different departments together and institutionalized the effort through successive mayoral administrations. "A lot of the work that's going on stems from MHHM…it's all sort of grown. Everybody's doing it now, not just us [Public Health and Wellness]" (Edwards 2014). To promote physical activity in the parks, the Mayor leads yearly "hike, bike, and paddle" events.

Public health concerns for green infrastructure were expressed in municipal plans in terms of providing opportunities for walking and bicycling. No participation of Louisville Health and Wellness was documented in plans reviewed.

7.1.4 Power and Collaboration

Successive mayoral administrations continue to advocate programs to promote physical activity and healthy living. In 2004, Mayor Jerry Abramson stated a vision to improve the quality of life for the newly merged Metro Louisville. In addition to MHHM and Mayor's Miles program, a complete streets policy[58] was adopted as an amendment to *Cornerstone 2020* in 2008. Mayor Greg Fischer has built upon those efforts, implementing complete streets by increasing the number of bike lanes (Eisinger 2013;

[58] https://louisvilleky.gov/sites/default/files/bike_louisville/complete_streets_ordinance.pdf

Edwards 2014), and expanding the hike and bike events to include boats, now referred to as 'hike, bike, and paddle.' Support for the Louisville Loop and MHHM initiatives continue to grow, and the city is taking steps toward physical activity as a sustainability issue (Sydnor 2013). Louisville's first sustainability plan (2013) reiterated goals for both physical activity and green infrastructure.

Local regulations were not perceived as barriers to implement green infrastructure. Although the EPA consent decree has influenced the design and realization of green solutions for stormwater management, interview respondents did not perceive local code requirements as barriers to implementation. Conversely, some expressed concern over a lack of regulations. Acknowledging the difficulty of integrating conservation and working landscapes, Mike Heitz, who served as director of parks in Austin prior to assuming that role in Louisville did not perceive any barriers in local regulations. Rather, he called for more stringent requirements: "Louisville doesn't have the level of environmental controls like Austin. With Louisville water isn't a problem, we've got plenty of water…so we haven't had that level of concern." Discussing her responsibilities in site plan reviews and permitting, planner Julia Williams observed current codes did not pose any detriments. However, she found no incentives to encourage developers to propose green infrastructure solutions. She explained, "you're relying heavily on the individual [agency] planner to introduce it into the projects, whereas I don't always want to introduce it. If you have a planner that's not as familiar, you're not going to get it." Without regulations for green infrastructure in the land development code, information may be disseminated inconsistently among project applicants.

Wes Sydnor concurred that he had not seen any restrictions in the land development code relative to stormwater management improvement projects. MSD has worked with Metro Council in review of the code to propose changes that would promote green infrastructure. Council has been receptive to changes, “but it’s a slow process. It just takes time to change.” The competition for open space from different departments with different missions continues to challenge open space preservation.

Initiatives such as MHHM and the Louisville Loop project foster collaboration among key participants. Participants shared their positive experiences relative to collaboration. Monthly meetings with department heads within the city provide a forum for open discussion and opportunity to work together on projects (Heitz 2014). “It helps to have everyone under the same umbrella to interact and communicate.” Steve Sizemore related his experience on the Loop project: “We have a monthly work group that has been meeting for four or five years now. I was invited to represent planning and design, and moved into full time working n the project. It’s been part of our mission to coordinate.”

Tensions exist between local agencies in meeting goals related to green infrastructure. Requirements stemming from the consent decree have presented problems in finding available land areas to mitigate water quality concerns and improve quality. One example rests in MSD’s proposal to build a holding tank under the great lawn in Shawnee Park, one of the three original Olmsted parks. Parks director Mike Heitz countered, “There’s just some challenges there because [MSD] is under consent decree and there [are] certain things they have to do. They’re looking at that open parkland.” Facing opposition from the parks department, Sydnor lamented, “Of course the mayor can overrule me. I mean you can talk about the power.” The competition for opens space from different departments with different missions continues to challenge open space preservation.

7.1.5 Measurement

Most respondents agreed that measurement of physical activity and green infrastructure would benefit their projects and initiatives. At the direction of Mayor Fischer, Louisville established the Office of Performance Improvement in 2012. LouieStat serves as one of its core programs to identify, track, and analyze key performance measures for each city department. While most lauded the use of measurements, responses varied as to what should be measured and how. There was concern among participants for goal setting. Different departments work toward achieving different goals (French 2014). Some mentioned the importance of precedent in illustrating the goals for green infrastructure, while others saw a need to show performance of green infrastructure in comparison to its gray counterpart. Leann French of Louisville Public Health and Wellness summarized the divergence of opinions, "We're not there yet. It's like we're not working together." The question remains as to what should be measured, as well as who should measure it.

7.2 Waterfront Park: Signature Project Findings

The goals for Waterfront Park envisioned access to the Ohio River, in a place where people could gather for social interaction through recreation and events that are held in the park throughout the year. The pedestrian and bicycle connection from Kentucky to Indiana has been realized with the completion of segments of the Louisville Loop and Big Four Bridge. Challenges from federal and state agencies for environmental approvals regarding navigability of the Ohio River and flood control impacted both site configuration and schedule for the project. Green infrastructure is represented conventionally in open space and tree plantings, yet few native species or naturalized areas exist throughout the park. The project, in part, has served as a catalyst for development in the Waterfront Overlay District and reconnecting downtown Louisville with its waterfront.

7.2.1 Green Infrastructure in Waterfront Park

Waterfront Park was a river reclamation project. According to WDC landscape architect Gary Pepper, emphasis for park acquisition and development centered on restoring the riverfront and access to and from downtown, “We haven’t [incorporated much green infrastructure at Waterfront Park]. We were before the green infrastructure movement…20 years ago.” In recent years, the EPA consent decree has required use of green solutions for stormwater management. The park, however, lies outside the limits of the decree (Sydnor 2013). One of the goals for the park was met in its creation of green space in an urban environment. The green space on the Great Lawn serves to mitigate flooding in the environs of the project.

The process of transformation from an industrial wasteland to an urban park necessitated creative solutions for flood control. “Flood issues were a major concern. The last thing we wanted was a flood wall,” expressed WDC director David Karem (Byck 2012). Concern for both visual quality and physical access to the water necessitated special foundation treatment of the 12+ acre (4.9 hectares) lawn area between Brook and Preston Streets. The lawn is built on a 12-inch (0.3 meter) sand base blended with peat moss and reinforced with geotextile fabric (Bell 2011, 328). The construction technique employed serves two purposes: 1) withstand compaction from thousands of visitors that attend events on the Lawn, such as the Kentucky Derby Festival and Fourth of July fireworks, and 2) accelerate drainage on the lawn enabling rapid recovery from periodic flooding.

Another design strategy used by landscape architect George Hargreaves involved tilting the lawn surface from its high point on Witherspoon Street, sloping downward to the river, a vertical difference of 28 feet (8.5 meters). Grading provided flood protection without requiring visually obtrusive floodwalls or gates (Bell 2011). River edge portions of the park were constructed on piers so that in some locations, water flows underneath the park (Wener et al. 2014). In this way, views to the river were enhanced, as well as physical access to the waterfront.

Tree planting was an organizing element for design. Gary Pepper emphasized the importance of tree canopy in the park as green infrastructure, noting it became an organizing element in the park. The allées and groves replicate the grids and lines of the spatial theme dictated by existing streets and bridges downtown (M'Closkey 2011). In addition to providing shade and wildlife habitat, the tree canopy reinforces the strong visual axes in the park.

7.2.2 Challenges to Multi-Phase Development

Phase I provided valuable lessons for subsequent park phases. Beyond the initial challenge of acquiring contiguous parcels of land for park development (Byck 2012), multi-phase construction benefitted later project phases. Inlet constructed in Phase I proved to be a maintenance problem in trapping debris, so proposed inlets were eliminated from future project phases (Pepper 2014). The linear park playground proved to be so popular, that play areas were expanded for the adventure playground. The spiral approach to the Big Four Bridge was delayed in phase III of the park due to geotechnical and potential flooding issues (Wener et al. 2014), and was completed in 2014. Gary Pepper described the park development as an intentional design with flexible spaces

(2014). A master plan for a fourth phase of the park was presented to WDC in 2014, confirming their description of the project as one that is open ended and continually evolving.

7.2.3 Foregrounding Connectivity: the Louisville Loop

Hargreaves' master plan incorporated elements of what would become the point of origin for the Louisville Loop. In addition to the goals expressed throughout *Cornerstone 2020* (2000) and its ancillary documents for an urban trail to traverse throughout the city, guidelines and standards were issued in 2009. Subsequently, the Louisville Loop Master Plan was adopted in 2013 to further guide the development and set forth standards for design and construction (Louisville Metro Council 2013). One of the concepts fostering connectivity lies in "loopsheds," defined as links within a network or defined space that feed into the main Loop pathway corridor, similar to waterways within a watershed (Louisville Metro Council 2013, 12). These links lie within one-half to one-mile (400 to 800 meters) radius from the Loop, and include streets, greenways, and other corridors that link the Loop with communities and destinations (12). The urban trail originating in the park offers the opportunity to connect with destinations throughout the Louisville area.

7.2.4 Site Audits: Evaluating Multi-functionality and Connectivity

Onsite evaluations were conducted April 9-12, 2015 utilizing the CfAD *Urban Design Checklist* in assessing major park features, with particular attention given to connectivity of use areas throughout the park and to adjacent downtown destinations within the WRO District. Presence of physical design characteristics and related green infrastructure elements were identified using the Physical Design Strategies checklist in eleven segments of the park. Table 7.2 portrays the results of the CfAD audit.

Table 7.2 CfAD Audit for Waterfront Park

CENTER FOR ACTIVE DESIGN

LOUISVILLE WATERFRONT PARK
SITE AUDIT and EVALUATION
April 9 - 12, 2015

CHECKLIST URBAN DESIGN

● Indicates Item addressed or present on site.
Additional comments are shown in italics.

2.1 LAND USE MIX

● When Planning for urban scale developments, provide for a mix of uses - for example, residences, offices, schools, retail stores, cultural and community spaces, and recreational facilities. **Park is part of 120 acre (48.6 hectare) mixed use development.*

● Locate places of residence and work near destinations such as parks, walking paths, trails and waterfront recreation areas. **In this case, the park was built first, residential development followed in vicinity.*

○ Develop supermarkets and full service grocery stores near places of work and residence.

2.2 TRANSIT AND PARKING

● Locate buildings and building entrances near public transit stops and along transit corridors.
○ Place public transit stops along well-connected streets.
○ Provide signage at buildings, transit stops, and major intersections showing a map and the distance, time, route and calories burned to the nearest or next transit stop. **Inadequate signage for pedestrians*
○ Encourage transit use by furnishing transit stops with pedestrian conveniences.
● Make sidewalks wide enough to comfortably accommodate pedestrians, including those with disabilities **Sidewalk widths vary.*
□ Provide additional space for passengers to wait by adding bus bulbs.
□ Create bus stop shelters that protect the users from sun, wind, and rain
□ Furnish bus stop shelters with seating or places to lean.
● When designing sites that include parking, consider how the provision of parking can affect the use of more active modes of travel such as walking, bicycling, and public transit.
● Provide parking for people with disabilities

2.3 PARKS, OPEN SPACES, AND RECREATIONAL FACILITIES

● Design open spaces as part of large -scale developments, or locate buildings near open, public spaces.

● Make bicycle and pedestrian routes to parks and public spaces safe and visible. **bike routes have few signs.*

● When planning a new development. Aggregate open space in one large area rather than dispersing into smaller pieces. Where possible, provide residents with access to open space within a ten-minute walk. **Observed both large scale areas for gathering such as the Great Lawn and amphitheater, as well as smaller spaces for playgrounds and active play.*

● In the design of parks or open spaces, provide paths, running tracks, playgrounds, sport courts, and drinking fountains. **not all drinking fountains were 100% operational at time of evaluation.*
● Locate new projects near existing public and private recreational facilities and encourage development of new facilities, including indoor activity spaces.
● When designing offices and commercial spaces, provide exercise facilities or walking paths nearby. ** Not applicable.*

● Design parks, open spaces, and recreational facilities to complement the cultural preferences of the local population, and to accommodate a range of age groups. **Age of range groups accomodated, cultural preferences not observed.*
○ Create partnerships with organizations to sponsor and maintain green spaces and gardens.

2.4 CHILDREN'S PLAY AREAS

Louisville: Waterfront Park *Page 1 of 4*

CfAD Audit for Waterfront Park, continued

CENTER FOR ACTIVE DESIGN

LOUISVILLE WATERFRONT PARK
SITE AUDIT and EVALUATION
April 9 - 12, 2015

● Design courtyards, gardens, terraces, and roofs that can serve as outdoor spaces for children's play
**No terraces or roofs observed as outdoor spaces for children's play; courtyards and gardens are present; Rolling topography compliments play areas.*

○ When designing playgrounds, include ground markings indicating dedicated areas for sports and multiple use.

● Preserve or create natural terrain in children's outdoor areas.

● Provide lights on sidewalks and active play areas to extend opportunities for physical activity into the evening.

● In the design of parks and playgrounds, create a variety of climate environments to facilitate activity in different seasons and weather conditions.

○ Provide physical activity facilities for children and youth in schools **not applicable*

○ Design new school physical activity facilities to potentially allow for public use outside of school hours. **not applicable*

2.5 PUBLIC PLAZAS

● Create attractive plaza spaces that are well-maintained.

● Locate public plazas along popular pedestrian streets.

○ Locate plazas near transit stops.

● Make plazas accessible to bicyclists.

● Create plazas that are level with the sidewalk.

● Design plazas that allow for diverse functions

○ Design plazas to accommodate use in a variety of weather conditions. **variety of weather conditions not observed*

○ Seek partnerships with community groups to maintain and program plazas. **not applicable*

2.6 GROCERY STORES AND FRESH PRODUCE ACCESS **not applicable*

○ Develop full-service grocery stores within walking distance in all residential neighborhoods.

○ Introduce farmer's markets as a complement to grocery stores.

○ Provide safe walking and bicycle paths between densely populated areas and grocery stores and farmer's market sites.

○ Design grocery store layouts and parking to accommodate pedestrian, cyclist, automobiles, and loading trucks safely and conveniently. Provide infrastructure such as bicycle parking a drinking fountains.

2.7 STREET CONNECTIVITY

○ In large-scale developments. Design well-connected streets with sidewalks and keep block sizes relatively small. ** Sidewalks and multi-use paths well connected throughout the park and with adjancent areas.*

○ Where current connectivity of sidewalks and streets on a building site is poor, provide pedestrian paths through existing blocks. **not applicable*

Avoid creating pedestrian over- and underpasses that force walkers to change levels.

○ Maintain dedicated pedestrian and bicycle paths on dead-end streets to provide access even where cars cannot pass. **not applicable*

● Minimize addition of mid-block vehicular curb cuts on streets with heavy foot traffic.

● Design vehicular driveways and ramps to minimize contact between cars and pedestrians.

2.8 TRAFFIC CALMING

● Design roads to be minimum width and to have the minimum number of lanes practical.

● Incorporate traffic calming street additions such as curb extensions, medians, and raised speed reducers. **Parking areas distributed throughout site for controlled access and minimal vehicle/pedestrian conflicts. Pavement change in festival staging area*

○ Consider other physical design measures where appropriate, for example:

□Horizontal deflections such as curved roadway alignments 'Vertical deflections such as raised intersections or crossings

●Traffic diverters, roundabouts, and mini-traffic circles **Traffic circles included at terminus of each parking area for drop off and turnaround.*

CfAD Audit for Waterfront Park, continued

CENTER FOR ACTIVE DESIGN

LOUISVILLE WATERFRONT PARK
SITE AUDIT and EVALUATION
April 9 - 12, 2015

□Signal phasing plan with a protected left-turning lag phase
□"Yield to Pedestrian" signs
□Avoidance of slip lanes and wide curb radii

2.9 DESIGNING PEDESTRIAN PATHWAYS

● Create a buffer to separate pedestrians from moving vehicles using street furniture, trees, and other sidewalk infrastructure. **wide sidewalks near River Road, with street furniture and trees.*
● Provide seating, drinking fountains, restrooms, and other infrastructure that support increased frequency and duration of walking. ** seating provided in high use areas , restrooms and drinking fountains near parking areas.*
● Provide exterior lighting along streets and outdoors paths. **street lights; path lighting in select areas*
● Include trees and objects of visual interest on streets and sidewalks.
● Make sidewalk widths consistent with their use.
○ Provide for enhanced pedestrian crossings both at mid-block and at intersections.
○ Construct curb extensions along sections of the sidewalk that tend to attract greater pedestrian congestion.
● Create or orient paths and sidewalks toward interesting views.
● Provide marked, measured walking paths on sites as part of a way finding system targeted to pedestrians and bicyclists. **Mayor's miles (not observed at time of site visit). Louisville Loop and Big Four Bridges provide distance information.*
● Make streets and paths universally accessible. Create:
□Paths that are smooth, sufficiently wide, and that have curb cuts and turning radii adequate for a wheelchair or walker.
●Paths with auditory crossing signals, adequate crossing time, clear signage , visible access ramps, and connections to walking, cycling and public transit routes.

2.10 PROGRAMMING STREETSCAPES

● Incorporate temporary and permanent public art installations into the streetscape.
● Organize pedestrian-oriented programs, such as charity walks and vehicular street closures, that make wide avenues available for walking and bicycling.
○ Increase the number of outdoor cafes to enhance street activity.

2.11 BICYCLE NETWORKS AND CONNECTIVITY

● Design interconnected bikeways and establish a backbone network of unbroken through routes.
○ Make links between bicycling and transit. **not evident at time of site observation*
○ On bikeways, include signposts providing bicyclists with directions, distances, and times to various destinations. **Louisville Loop route clearly marked, directions and distances indicated for downtown destinations.*

2.12 BIKEWAYS

○ Use on-street markings or signage to visually reinforce the separation of areas for bicyclists and motorists.
● Where conditions warrant, separate bikeways and vehicular traffic lanes with physical demarcations. **not applicable*
○ Expand existing bikeways where use has exceeded capacity
○ Pay special attention to the treatment of bikeways at intersections and other points where the street form changes, in order to mitigate potential visibility issues and turning conflicts.
○ Avoid potential conflicts between cyclists and opening car doors - for example, by widening parking lanes where appropriate.
● Further develop Greenways - alternate routes that are integrated into the regional park system. **sidewalk and trail connnections to both downtown and River Road recreation sites.*
● Consider shared-use paths in areas with viewing attractions.

2.13 BICYCLING INFRASTRUCTURE

● Provide adequate facilities for bicyclists to park along their route or at a final destination.

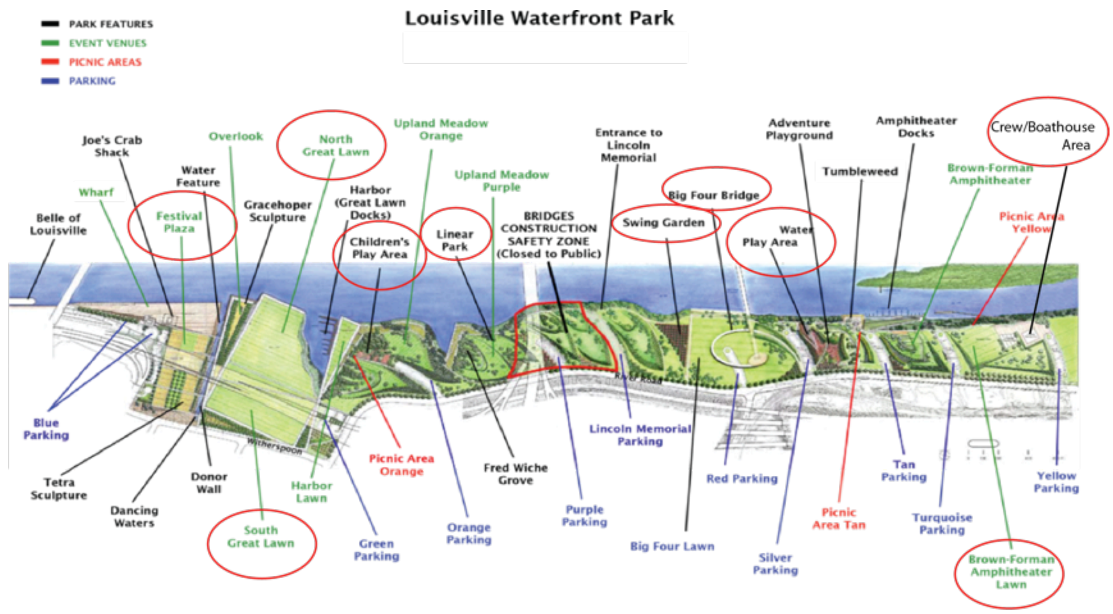
CENTER FOR ACTIVE DESIGN

LOUISVILLE WATERFRONT PARK
SITE AUDIT and EVALUATION
April 9 - 12, 2015

- ● Designate bicycle-specific crossings and signals to organize the movements of pedestrians, cyclists, and motorists at busy intersections. **at Louisville Loop point of origin*
- ○ Construct bicycle share programs to increase access to bicycles for both city residents and visitors. **bike share not observed onsite.*

Based on observations from both a pedestrian and bicyclist perspective, the site works well, offering a variety of settings and spatial scales for both organized and informal physical activity. The park provides opportunities for both land based and water based activities. The harbor contains spaces for pleasure boats to dock, and two launches facilitate kayak use. Two boathouses–one for the Louisville Rowing Club, the other for the University of Louisville Rowing team–are located on the eastern portion of the park. Trails and walkways wind throughout the park, with a continuous walkway along the riverfront, and connections to nearby destinations, such as Louisville Slugger Field, the Belle of Louisville steamboat launch and museum, and commercial and residential establishments. The Louisville Loop begins at the Big Four Bridge, and continues to the west along the riverfront, as well as connecting to locations downtown, and across the bridge to Jeffersonville, Indiana.

The Physical Design Strategies Checklist served as tool to assess the presence of physical design characteristics and corresponding green infrastructure elements for ten activity areas within the park. A more detailed analysis was performed using the Physical Activity Inventory Audit. A map of the park illustrates the areas evaluated in Figure 7.2, followed by the audit form in Table 7.3.



Areas Evaluated Indicated by :
Festival Plaza
North and South Great Lawn
Children's Play Area (West Play Area)
Linear Park
Swing Garden
Big Four Bridge
Water Play Area
Adventure Play Area
Brown-Foreman Amphitheater Lawn
Crew Boathouse Area

Figure 7.2 Key Map for Physical Design Strategy Analysis Locations (base map from www.louisvillewaterfrontpark.org)

Table 7.3 Physical Design Strategies Audit for Waterfront Park

Inventory: Physical Design Strategies on Case Study Projects
City: LOUISVILLE
Waterfront Park
April 9-12, 2015

	Indicates item is present on site
	Indicates some items present or item not adequately represented on site
n/a	Item not applicable to specific site
	Indicates item not present on site

		Location										
		Festival Plaza	Mayors Mile*(1)	North Great Lawn	West Play Area	Linear Park* (4)	Swing Garden	Big Four Bridge	Water Play Area	Adventure Play	Amphitheater	Crew Area
Access												
Legibility	Ease of movement throughout activity areas in the park											
	Clearly visible and multiple access modes to the park											
	Respectful of terrain											
Coherence	Separation of Traffic Modes - car, bicycle, pedestrians, transit											
	Aggregation of open space in large central area							n/a				
Tidiness	Trails with good surfaces											
	Provision for areas made for sun in winter, shade in summer											
Connectivity	Trail connections to offsite trails and parks											
Context	Neighborhood access encourages park use*(2)						2					
Comfort and Safety												
Legibility	Safe and visible pedestrian and bicycle routes within the park											
	Benches											
	Restrooms - location and proximity to use areas											
	Drinking Fountains - location and proximity to use areas											
Coherence	Lighting on Trails and Activity Areas for Extended Use											
Complexity	Effective Use of Native Materials, establishment of identity											
Tidiness	Condition of Facilities and Equipment											
	Little or no evidence of debris, litter											
Active Engagement												
Legibility	Centrally visible activity spaces											
Context	Proper orientation for sports courts, etc.	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Location of park relative to other existing public/or private facilities (co-located for shared resources)								n/a			
Diversity	Multiple facility types and uses provided											
	Flexible Open Space Provided											
Complexity	Facilities co-located to optimize simultaneous p/c activities											
	Motivational decision prompts placed to encourage mobility											
	Curvilinear roads and paths											
Connectivity	Connection to multi-use paths											
	Marked distance trails											
Discovery/Fun												
	Different Experiences created for road and path users											
	Create or preserve natural terrain in children's play areas	n/a		n/a			n/a	n/a			n/a	
Green Infrastructure Elements/lands												
Park												
Open Space												
Stormwater Management Areas												
Street Trees/street right of way												
conservation area												
other												
urban agriculture/fruit trees												
native prairie habitat												

*1. Mayor's Mile not marked at this time.Was signed on previous visits.
*2. In this project, park development preceded development of nearby residential areas.
*3. Restrooms are located adjacent to parking areas throughout the park.
*4. Portions of trails along the river were under water (flooded) at time of assessment.

Site evaluation strongly suggests that Waterfront Park met its design goals for development in the integration of use areas and connecting the riverfront to downtown. Although green infrastructure within the park did not demonstrate cutting edge green technologies, the use of the Great Lawn for flood control and use of trees represent green infrastructure elements on site. Mike Kimmel, assistant director for WDC referenced the flexible and multifunctional spaces within the park. Turf covered berms and angular plinths organize and define spaces within the park, and allow for playful interactions traversing the changes in topography. The linear park wedge–shaped berms are situated over 20 feet (six meters) above the walkway along the river (M'Closkey 2011), offering views to various locations in the park and beyond. Connectivity is evident from the bikeways and sidewalks that link not only to downtown, but also to sports and recreation facilities east of the park along the River Road corridor.

The Louisville Loop has contributed to riverfront connectivity. With the opening of the Big Four Bridge to bicycle and pedestrian traffic in 2013, visitors could access the river from above; the bridge provides, through signage along the bridge, a chronology of the bridge and history of the Ohio River in Louisville. Connection to the Indiana segment of the trail in Jeffersonville extended the trail in 2014, with plans to integrate the Ohio River Greenway in southern Indiana.

While trees have been planted throughout the park, critics note a lack of native and indigenous species and extensive turf areas. The berms throughout the park offer open play areas, yet few native tree species or other types of native vegetation are located throughout the park. With recent emphasis on water conservation and sustainable landscape maintenance practices (Wener et al. 2014), the park could improve such practices to be in line with changes in some of the city's Olmsted parks. For example, Cherokee Park has traded former turf areas for less maintenance intensive meadows with native and indigenous grasses in areas not experiencing high traffic.

7.2.5 Public Health Considerations

With the exception of the segment of the Louisville Loop in Waterfront Park, public health considerations responded to mitigation of environmental contaminants from previous industrial land uses. Mike Kimmel, WDC vice president, directed the environmental documentation for the project, and permit applications with the Army Corps of Engineers (USACE). Contaminated soil was hauled off site, with topsoil retained to construct berms and hills in the Linear Park. According to Steve Sizemore, planner for the Loop, he organized the preparation of a Health Impact Assessment for the Loop in 2012, funded by a CPPW grant. The effort involved training and certification of participants in the plan, partnering with the University of Louisville Public Health and Wellness Department. At the time of the study, approximately 25 miles (40.2 kilometers) of the trail had been competed. According to Sizemore, the city is now implementing study recommendations.

7.2.6 Power and Collaboration

Challenges for project approval centered on navigation and flood control issues. As the WDC was established through a legislative action sponsored by the state, city of Louisville, and Jefferson County, there were no challenges adhering to local codes and ordinances (Kimmel 2013). However, compliance with federal agencies, such as USACE and the Coast Guard resulted in a three-year effort. USACE issues focused on flood control and water quality, while the Coast Guard concerns involved maintaining navigability in the main channel around the proposed harbor (Bell 2011, 296). In response to agency concerns, the docks were built on telescoping piles to allow docks to fluctuate with changes in river water elevations. Flood control was achieved through regarding of the Great Lawn area, and construction of the riverfront walkways on structure to allow water underneath the park.

WDC established a proven track record for collaborative efforts. Gary Pepper described the collaboration efforts of WDC: "We're kind of rule breakers…we've got such a good track record…managing tenants in the park, our neighbors and getting them to build way beyond their original vision." The willingness to work with people has resulted in positive collaboration in the park as well as in the WRO overlay district. The WRO is managed by WDC, with plan review assistance from the local chapter of the American Institute of Architects. Critics have questioned the influence of the WRO in terms of aesthetics, citing lackluster design in some of the adjacent properties (Wener et al. 2014).

Project maintained continuity through WDC staff and consultants over the three phases of the project. "David Karem [WDC President] took the project on, volunteering his time at the beginning. He started pulling a few people together and having some meetings and then they gave him a contact position" (Pepper 2014). His presence has been constant over the course of the project. According to WDC staff members, his influence and collaborative efforts were instrumental in making the park contiguous and improving accessibility through the rerouting of River Road, relocation of the Interstate 64 freeway ramp, and the construction of Witherspoon Road along the landside periphery of the park. The WDC staff has had little turnover since its beginning in 1986. Hargreaves and Associates designed the master plan, as well as being on board for the three phases of design (Kimmel 2013). The stability of WDC was apparent in the transformation of the project through all phases of development.

WDC met the master plan goal of providing a level of service beyond tradition park maintenance. Another participant in the continuity of Waterfront Park's successful efforts is Gary Pepper, the landscape architect charged with managing park maintenance. Hired by WDC in 1996, he reviewed park plans prior to construction to minimize potential maintenance problems (Kimmel 2013). Exceptions to WDC maintenance include contracting additional security services for over 150 events held at the park each year (Pepper 2014). According to designer George Hargreaves, maintenance issues surfaced early in the process, requiring replacement of meadow grasses with turf and reduction of proposed inlets (Wener et al. 2014). Fluctuations in water levels have also affected bank stabilization, and evidence of erosion was observed on site visits to the park.

The river presents significant landscape maintenance challenges. A significant landscape maintenance challenge lies in what Pepper refers to as 'nuisance flooding.' As the Great Lawn functions as a flood control area, it is subject to collection of debris, including large logs (Bell 2011, 328). Inundation impacts the portion of the trail along the river in the eastern portion of the park, partially under water at the time of site evaluation. Pepper and his staff collect the debris and dispose of it, keeping the area intact for its numerous events.

7.3 SUMMARY

In response to requirements outlined in an EPA consent decree, Louisville's Municipal Sewer District has shifted from conventional design solutions to projects utilizing innovative green infrastructure strategies that are cost effective and aesthetically pleasing in city projects. While current codes do not pose detriments, few incentives exist to encourage developers to propose green infrastructure solutions. A strong central government structure enables collaboration among departments to address problems such as a decline in tree canopy and heat island effects. Successive mayoral administrations have advocated public health and wellness through the Mayor's Healthy Hometown Movement, and CDC grants have contributed to projects such as the Louisville Loop. The development of Waterfront Park reconnected the riverfront and downtown, both physically and visually, establishing a strong base to revitalize downtown properties in the park vicinity. With the origin of the Louisville Loop in the park, the trail links downtown to a regional trail network in Kentucky and Indiana.

Chapter Eight: Portland–Between the River and the Freeway

This chapter outlines study findings for Portland, Oregon at both the municipal and project levels. Following the format in Chapters Five, Six, and Seven, presentation of findings is generally aligned with research questions–beginning with an overview of patterns emerging from review of municipal plans and perceptions of interview respondents at the city scale: perceptions of green infrastructure, as well as how it relates to physical activity; issues of power and collaboration; and perceptions as to what items should be measured for green infrastructure that promotes physical activity. A summary of the analysis for the Eastbank Esplanade synthesizes information obtained from site observation, site audits, and semi-structured interviews of key participants.

The Eastbank Esplanade provides opportunities for recreation in its 1.5-mile (2.4 kilometers) course along the Willamette River. Its contribution to Portland's development lies in establishing a major link in pedestrian and bicycle circulation downtown, reclaiming derelict land for recreation and active transportation, and restoring portions of the riverbank with native plants for stabilization and wildlife enhancement. Providing a critical link in a series of loops downtown, it connects to both local and regional systems of pedestrian and bicycle facilities, including the regional 40-Mile Loop. The project integrates goals and objectives in both state and local plans for conservation and livability.

Emergent patterns in Portland include: integration of green infrastructure in the city, acknowledgment of multiple green infrastructure concepts and principles, a strong association between green infrastructure and physical activity in terms of multi-functionality and connectivity, challenges with federal requirements and water quality, and concerns for bureau responsibilities for maintenance of facilities.

8.1 Municipal Scale Findings

Four plans comprise the evaluation of Portland's municipal issues relative to green infrastructure and physical activity. These include: *Comprehensive Plan 1980,* including amendments through November 2011; *Portland Watershed Management Plan, 2006, and 5-Year Implementation Strategy 2012-2017*, which identifies Portland's comprehensive approach to improving current watershed health; *Portland's Green Infrastructure: Quantifying the Health, Energy, and Community Livability Benefits* (2010), intended to guide infrastructure decision-making; and associated parks and recreation documents utilized in planning–the *Parks Vision 2020, 2009 Progress Report, and 2012-2015 Strategic Plan*.

Collectively, these plans establish a strong foundation to guide planning in Portland. The plans clearly articulate goals and objectives that support green initiatives and physical activity. In terms of stormwater management, Portland has pioneered efforts in green infrastructure (Mayer–Reed, Macy 2013). Physical activity contributes to green stormwater solutions as an ancillary use, where compatible (Liptan 2013). Conversely, the plans prepared by Portland Parks and Recreation emphasize opportunities for recreational physical activity in concert with ecological management practices. A summary of municipal plan findings is provided on Table 8.1.

Table 8.1 Summary of Portland Municipal Plan Review

	Comprehensive Plan 1980, Including amendments adopted through 11/2011	Parks Vision 2020 (2001), Progress Report(2009), and Healthy Parks, Healthy Portland Strategic Plan 2012-2015 (2012)	Portland Watershed Protection Plan (2006), and 5 Year Implementation Strategy 2012-2017 (2012)	Portland's Green Infrastructure: Quantifying the Health, Energy, and Community Livability Benefits (2010)	Comments
PLAN CONTENTS					
Authorship (all list public participation as contributing to authorship)	Bureau of Planning, committee for citizen involvement, public agencies (not identified individually)	Vision Plan and progress report prepared by Parks; no authorship listed in Strategic Plan	Environmental Services project staff, Bureaus of Planning, parks and recreation, and input from state and federal agencies	Prepared by consultant ENTRIX for Bureau of Environmental Services; report references health, but no participation listed from health department	Participation listed in all but Parks Strategic Plan
Clearly stated purpose, goals, and objectives	Provides a set of land use and public facilities goals and policies to guide future growth: map, guide for investments to implement plan, and process for review and plan amendment	Five goals in original plan in 20 year timeframe, including making Portland a walking city; 2009 report refined goals and developed grading system for measuring progress; strategic plan further refined goals and established agenda for meeting goals	Comprehensive approach to improving current watershed conditions; Relies on integrating action from multiple city bureaus, acknowledging interconnections across disciplines. Goals addressed citywide and also directed to specific initiatives	Main purpose of report is to utilize Bureau of Environmental Services planning and alternative analysis for prioritizing projects, and become part of infrastructure decision making	Goals clearly stated
Policies related to green infrastructure	Term not specifically referenced	Several references made to green infrastructure	Term green infrastructure not used; referenced in 2012-2017 Strategic Update	Expand green infrastructure by its BMPs: construct ecoroofs, green streets, planting trees in urban area, planting in natural areas	Concepts discussed, yet terms are inconsistent among plans
Policies related to physical activity	Connectivity for pedestrians, bicycles, and multi-modal transportation	Health theme of plan: expand recreation by partnering with public health community	No reference to physical activity	Sections 3-Health, and 5-Livability discuss green infrastructure and physical activity relative to research	Referenced in all but Watershed Management Plan
Policies Linked to Specific Action	Goal to protect and preserve natural and economic qualities along Willamette River through implementation of Willamette Greenway plan	Extend ecologically sustainable landscape management practices; develop performance standards for green infrastructure	Listed in 2012-2017 Strategic Plan	inform comprehensive plan update; mayoral efforts to promote green infrastructure	Strategic Plans list action items

Summary of Portland Municipal Plan Review, continued

	Comprehensive Plan 1980, Including amendments adopted through 11/2011	Parks Vision 2020 (2001), Progress Report(2009), and Healthy Parks, Healthy Portland Strategic Plan 2012-2015 (2012)	Portland Watershed Protection Plan (2006), and 5 Year Implementation Strategy 2012-2017 (2012)	Portland's Green Infrastructure: Quantifying the Health, Energy, and Community Livability Benefits (2010)	Comments
FACT BASE AND CONTENT					
Elements Specific to Green Infrastructure and Physical Activity	Section on pedestrian districts, and linear parkway preservation	Proximity of residents to access recreation and natural areas within 1/2 mile (0.3 km) of home	Terms not used; green infrastructure listed in 2012-2017 Strategic Plan	Section 3 and 5 reference both green infrastructure and physical activity in terms of positive health relationships	Each plan mentions policies, yet information varies among plans
Issues addressing multi-functionality and connectivity	Pedestrian access, and priority given to access in existing or planned high areas of activity. Pedestrian gap map	Proximity to include all open space areas, not just those owned by Parks	Enhance livability through access to natural environment	Discussed with reference to Millennium Ecosystem Assessment and ecosystem services; multiple benefits of greenness to physical and mental health	Livability, proximity, and multiple benefits of green environment to human health
Integration of green infrastructure into plan	Conservation and enhancement of drainage ways and linear parks	Performance measures and improvements to green infrastructure	Concepts addressed throughout the plan, oriented to biological and biophysical linkages, habitat improvement	Supports infrastructure decision for city and encouraged to be used by other bureaus	Listed in all plans
PLAN PROPOSAL					
Spatial Design	Maps show future green access ways for crossing Willamette River	Interconnected trails and links to healthy lifestyles; connect more youth with outdoors	Green streets listed as strategy to improve watershed health; creatively integrate stormwater into the built environment	Health subgroup focused on air quality, physical health, and mental health as three primary health benefits that may result from use of BMPs	Green connectivity, health benefits for both watersheds and humans
Implementation time table	No specific time frame for green infrastructure or physical activity; plan for green streets provided, but no schedule	Strategic Plan re-aligns timeframes from original plan, updates what goals were met, not met, and why	Includes both short term and long term tasks; Coordination with Grey to Green initiative to expand natural stormwater management and green infrastructure	No specific time table mentioned for implementation, as most initiatives are ongoing	Referenced in strategic plans
Identification of signature project in plan (Eastbank Esplanade)	No specific reference	Referenced in Parks 2020 Vision Plan, Sub area Central/ NW	No specific reference	Not referenced	In Parks 2020 Vision Plan

Summary of Portland Municipal Plan Review, continued

	Comprehensive Plan 1980, Including amendments adopted through 11/2011	Parks Vision 2020 (2001), Progress Report(2009), and Healthy Parks, Healthy Portland Strategic Plan 2012-2015 (2012)	Portland Watershed Protection Plan (2006), and 5 Year Implementation Strategy 2012-2017 (2012)	Portland's Green Infrastructure: Quantifying the Health, Energy, and Community Livability Benefits (2010)	Comments
Integration of green infrastructure into the plan	No specific time frame given; reference to drainage and linear greenways	No specific green infrastructure plan, but lists connectivity as major goal	Goal to integrate green infrastructure approaches to stormwater management projects	Tables are presented for ways to measure benefits of ecosystem services	References integrate ecosystem services
PLAN CONSISTENCY					
Federal and State mandates	Strong framework by state sets forth comprehensive plan requirements	Reference to Endangered Species Act recommendations for fish habitat	NPDES MS4 permit emphasized the use of green infrastructure to address stormwater problems; Endangered Species Act challenges with potential new species list	Compliance with requirements of Endangered Species Act, Clean Water Act, Safe Water Drinking Act, and State Land Use planning goals	Strong emphasis on CWA, ESA, and State Land Use Planning Goals
Coordination with Federal/State agencies	Comp plan to be coordinated with federal and state law and support regional goals and plans of METRO	Reference to meeting CDC goals for physical activity	Oregon Department of Environmental Quality	Coordinate NPDES requirements to reduce stormwater pollution	NPDES
Regional Coordination	Discussed through METRO administration	General discussion of collaboration	Plan lists compliance with regional requirements	Coordination with agencies referenced	References to METRO
Coordination among city agencies	Link to transpiration and Parks master plans; references certain city bureaus to develop plans required by comprehensive plan	Identified conflicts with other municipal plans, consistency with comprehensive plan	Plan mentioned integration of green infrastructure approaches with comprehensive plan and transportation system plan	References consistency among plans as well as among bureaus for consistency	Consistent cross-referencing

In addition to establishing goals and objectives across departments, referred to as 'bureaus' in Portland, the plans recognize limitations relative to urban design and measurement in meeting prescribed goals. The Urban Design section of the comprehensive plan (2011) expresses the goal to foster innovative solutions to meet the goals in guidelines of design acceptability;" it subsequently acknowledges that an innovative solution may require exceptions to explicit guidelines to accommodate interventions of great quality and sensitivity to Portland's character. Toward that goal, the city established specific zoning requirements that further the implementation of the urban design goals and the goal's associated policies and objectives. The *Parks Progress Report* (2009) highlights inconsistencies between the Parks Plan and Urban Forest Management Plan, citing the need for developing an indicator for connectivity of natural areas, and pinpointing the original park plan's lack of structure to assess whether or not it was meeting stated goals.

The *Watershed Management Plan* (2006) expresses an overarching goal of improving watershed health in Portland. While it focuses on enhancing water quality through green infrastructure solutions, the plan also identifies potential problems with greenspace enhancement project that are not properly designed–losing intended effectiveness and harming watershed health. The influence of green infrastructure in Portland has been well established, informed by municipal plans and perceptions of key interview participants.

8.1.1 Perceptions and Patterns of Green Infrastructure

Interview participants perceive green infrastructure as an integral component of its city fabric. Parks Director Michael Abbaté summarized green infrastructure as "a key part of our identity as a community, a widely held community value." Portland's Bureau of Environmental Services (BES) pioneered green infrastructure solutions in the late 1990s by testing experimental designs for vegetated swales, finding them to be a more effective solution than traditional turfgrass swales (Wise 2008). Tom Liptan, former

BES environmental planner, explained that effective solutions resulted from pilot projects constructed to "prove it would work." According to Eric Engstrom, principal planner with the Bureau of Planning and Sustainability, the city spent the last twelve years overhauling sewage infrastructure piped underneath the Willamette River.

Green infrastructure was found to be more cost effective than construction of large pipes, resulting in solutions employed for economic as well as environmental reasons (Engstrom 2013; Liptan 2013). For example, Portland's Tabor to the River Program, a 2.3 square mile (6 square kilometers) area between SE Powell and SE Hawthorne Boulevards to the Willamette River, used a variety of stormwater management techniques to solve problems caused by an inadequate sewer system that resulted in overflow to the river. The program includes such measures as tree planting, green streets, and repair and/or replacement of 81,000 linear feet (24,689 meters) of sewer pipe. Employing only pipes, the project costs were estimated at $144 million. Incorporating green infrastructure projects reduce the estimated costs to $81 million.[59] Acknowledging the drive to mitigate water quality, Tom Liptan expanded the vision, "it's is an essential part of transforming the city into a more beautiful place." Others commented on the city's total commitment to green infrastructure, and its role as a pioneer at the forefront of stormwater management with green solutions (Macy 2013; Mayer–Reed 2013). Interview responses reinforced the national reputation Portland has gained in its planning and implementation of green infrastructure. Municipal plans reference green infrastructure specific to each plan's goals and objectives, and integrate ecosystem services as a way to measure benefits.

[59] www.portlandoregon.gov/bes/47591

Acceptance of green infrastructure has changed over time. Pilot projects testing green infrastructure for stormwater runoff treatment began in the 1990s (Liptan 2013). A growth process for green infrastructure followed successful completion of small projects (Perry 2013). In addition to the testing of strategies to guide future projects, the development of the Watershed Management Plan in 2005 provides a policy basis to integrate green infrastructure, shifting away from the separation between hard [gray] infrastructure and green solutions (Walkiewicz 2013). As landscape architect Kevin Perry stated, "What was once a new idea is now commonplace and established…a mainstream concept." A perceptible change highlights consideration of how capital projects are funded. Such consideration has contributed to elevating green infrastructure from an amenity to a necessity.

Perceptions of green infrastructure acknowledge multiple concepts. While most respondents concurred with the emphasis on stormwater management, other factors contribute to a more holistic interpretation of green infrastructure. Eric Engstrom explained its breadth of application in the work done by the Planning Bureau, "it's been a high priority and one of the organizing principles for a lot of the work that we do." According to Carol Mayer–Reed, "We're always mindful how the project fits into a larger context–how do people walk to it? How do they view it? Are they inspired by something that's offsite?" Others described a wide band of projects and places demonstrating green infrastructure principles as partly functional and partly aesthetic–including recreation and conservation lands.

Best management practices have been misused as a recipe book for solutions. One of the goals in Portland's Green Infrastructure Plan (2010) strives to expand green infrastructure by its Best Management Practices (BMPs) through the construction of ecoroofs, green streets, and tree planting in both urban and natural areas. While use of

BMPs intends to advance green technologies and practices, interview participants expressed concern for limitations and misuse as attachments to design: “Sometimes the wheels of the bureaucracy get out of ahead of conventional wisdom about where to put this stuff…it has been codified that people use these strategies as a recipe book, and they decide these facilities need to be so many feet on center…it doesn’t [always] line up [with programmed site elements]” (Mayer–Reed 2013). Further commenting on what seems in some instances like a ‘cookie-cutter’ approach, Kevin Perry posited, “What works in one neighborhood may not work in another. We go quickly to standards without having a full toolbox [of green infrastructure strategies].” Planner Marie Walkiewicz reiterated the concern, but noted progress being made: “BES allowed some investment in trying to construct new technology and monitoring and revising them to get better quality design. It has taken a while to work across the lines between typical type engineering and green infrastructure.” Respondents recommended use of guidelines rather than rigid standards to provide flexibility in design, pairing BMPs with critical thinking.

8.1.2 Relating Green Infrastructure and Physical Activity

Findings suggest a strong positive association between green infrastructure and physical activity. Municipal plans reference connectivity and multi-functionality throughout, particularly with regard to ecosystem services, proximity to recreation, and access to the natural environment.

The Watershed Management Plan (2006) outlines biological and biophysical linkages for habitat improvement, with access to natural areas as ancillary to watershed protection and health. In the five-year implementation strategy (2012), action items appear to be fairly consistent with Watershed Management Plan–green infrastructure that promotes physical activity is ancillary to watershed improvements such as habitat connectivity and water quality improvement.

The comprehensive plan (2000, as amended) lists priority given to pedestrian access in high areas of activity, and provides a map delineating gaps in pedestrian connectivity. Interview respondents articulated a symbiotic relationship between green infrastructure and physical activity. "Physical activity needs to be completely interwoven with green infrastructure…I don't think you can have good physical activity without some amount of green infrastructure" (Perry 2013). Functional aspects of green infrastructure were also discussed in terms of compatibility with facilities for physical activity, such as trails in conservation areas and bioswales next to bike paths. Although green infrastructure may not always be compatible with physical activity in terms of such improvements as ecoroofs, benefits of compatible projects illustrate the catalytic value of multi-functionality and connectivity.

8.1.3 Public Health Considerations

Budgetary constraints may limit levels of support for health initiatives relative to physical activity. The Multnomah County Health Department[60] is the lead agency addressing health issues in the Portland area. With a vision of "healthy people in healthy communities," the agency serves in partnerships with the county's eight municipalities and several unincorporated communities to promote and protect the health of its citizens. Parks Director Mike Abbaté expressed concern for limitations of partnering efforts with the health department: "There are budget constraints...City helps supply some funds, but

[60] https://multco.us/health/

everyone is not under the same regulatory or budgetary umbrella." Designers interviewed expressed a desire to be more interactive with the health department on projects and programs.

Although public health department staff members were not specifically identified in authorship of municipal plans evaluated, interviewees identified participation in programs and physical activity initiatives. The planning bureau has worked with the Multnomah County public health department on concepts of relating green infrastructure with health and physical activity, and the bureau sends out a monthly newsletter on a number of issues including policy information on healthy eating and wellness (Engstrom 2013). The Parks *2012-2017 Strategic Plan* outlines strategies related to physical activity under its health initiative section, and health department was involved in preparation of the draft comprehensive plan and its companion document *The Portland Plan (2012)*. According to planner Eric Engstrom, the health department has been active in obtaining grant money from CDC, supporting planning work related to health and wellness.

Participants identified Safe Routes to School as a public health issue. Tom Liptan, former BES environmental planner, shared concerns for the program and the need for students to commute safely, stating, "We use stormwater money for safe routes to school." BES supports other goals for green infrastructure that promotes physical activity, such as tree planting, but faces limitations. Since funding for BES initiatives utilize revenue from utility rates, there has to be a direct connection to the mission of the bureau (Walkiewicz 2013).

8.1.4 Power and Collaboration

Multiple agencies must get involved to make projects work. "We look at it from the long range planning perspective, in terms of networks and projects that are network oriented-drainage facilities that tie together but have watershed function; on the ground projects usually involve a combination of at least three different agencies" (Engstrom 2013). Part of the synergy developed between active transportation and stormwater management is attributed to the shrinkage of city budgets. Each agency manages its own priorities for funding, but more recently combined objectives into multiple functions to obtain resources to complete projects. Michael Abbaté commented on successful collaborations such as the gray to green program[61] to create water reservoirs within city parks. Work among bureaus on multiple projects has transformed cycling in Portland from a recreational activity to an integral component of multi-modal transportation.

Environmental goals sometimes compromise user experiences. Providing safe and healthy habitat for salmon and steelhead trout largely influences environmental concerns for water quality in Portland.[62] At times, this has caused conflicts between allowing people access to the river and protecting fish habitat. The South Waterfront illustrates a case in point. According to landscape architect Doug Macy, whose firm participated in design of the project, "South Waterfront employed the most rigorous solutions to issues of dealing with green infrastructure all the way from cleaning water off the streets to dealing with in water conditions and banks." Segments of the river in the city present challenges to safe passage for salmon, and dense upland vegetation helps create habitat in the water, but obstructs human access to the waterfront (Mayer–Reed 2013). Code challenges and jurisdictional boundaries test both the visual and functional

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[61] https://www.portlandoregon.gov/bes/47203
[62] http://www.salmonsafe.org/

essence of design. “The idea of the Willamette Greenway is that really big, muscular gesture to connect people to the water and connect them along the river…Do we want to design in such a way that all those [jurisdictional] boundaries are really tight and obvious? Or do we want to have some gray area in terms of how we can use space, and as long as they’re doing it appropriately, is that acceptable?” Portland bureaus continue to address the issue as they draft the newest version of the comprehensive plan.

The municipal plan hierarchy works toward implementation of goals and objectives. The layering of municipal plans incorporates goals and objectives from broad to fine grain in application. Plans prepared by Portland Parks and Recreation illustrate the concept. Broad goals and objectives are stated in the *Parks Vision 2020* (2001). The 2009 *Progress Report* refines the goals, with a grading system for measuring progress. The *Healthy Portland Strategic Plan 2012-2015* (2012), establishes short-term goals and strategies for implementation in accordance with the other plans. Michael Abbaté explained the relationship of these plans to those done by other bureaus: “I think [collaboration] starts with being involved in each other’s long range plans…we try not to be siloed in our approaches…being at the table when a transportation bureau or planning bureau is creating a long-range plan…that’s where it starts.” Working on the draft comprehensive plan, which was underway at the time of data collection for this study, provides the opportunity to bring people and bureaus out of their respective silos. In this forum, members of different bureaus work together to address competition over land resources, such as how much land is needed for stormwater management versus what is needed for recreation (Mayer–Reed 2013). Translating from policies to design presents challenges, and collaboration on built works focus on the project scale.

As much as bureaus collaborate in plan preparation and individual projects, concern was expressed over the lack of a holistic approach. The Portland structure of governance places city commissioners in charge of specific city bureaus. Without a strong central government to oversee the broad vision, implementation remains somewhat fragmented. According to Eric Engstrom, "We have a lot of different agencies that have specific missions and boundaries for those missions, and so it sometimes can get in the way of integrated thinking because each agency has their own limited agenda and has blinders on at the boundaries…there's no one agency that has, to serve as the keeper of the big picture, that has control over everybody." Tom Liptan explained the success at the project level as needing "some kind of driver." In other words, without a reason to get together to make things better, projects are not initiated. Centering on a problem to solve appears to gain momentum to accomplish objectives, occurring when strong political champion facilitates interdepartmental coordination (Engstrom 2013). One such problem is the protection of salmon migration, to which one respondent simply offered, "Salmon is a big deal. [It] brings people together to say, ok we need to do something." The project level shows success, but concern and unanswered questions remain at the municipal level.

Large-scale initiatives have been completed, but policy and implementation issues reside at the detailed level. Most of the multi-functional projects concentrate efforts on major arterials in combining stormwater, bicycle and pedestrian ways (Engstrom 2013; McTighe 2013). This raises a policy question as to who is going to do all the necessary retrofitting at the local street level (Engstrom 2013). Sidewalks and street trees are the responsibility of the property owner that is adjacent to the road. Eric Engstrom explains, "the city doesn't really take responsibility for the local streets that much. We do a lot of bike and stormwater and sidewalk projects that are all good things in terms of green infrastructure and physical activity, but most of that work is on major arterials, so there's kind of a policy issue about who's going to do all the necessary retrofitting that the local street level." The issues transcend not only to equity issues, but also raising questions as to maintenance and management responsibilities.

8.1.5 Maintenance and Management Responsibilities

A spectrum of services for green infrastructure management and maintenance is divided between BES and the Parks and Recreation Bureau. BES essentially oversees the stormwater management aspects of green infrastructure, including issues involving compliance with federal Endangered Species Act (ESA) and Clean Water Act (CWA) regulations (Abbaté 2013). Parks and Recreation assumes responsibilities for the tree component of green streets and urban forestry. These living systems require ongoing maintenance that has been challenging to quantify (Abbaté 2013). The maintenance issue continues to grow as more facilities are constructed, and BES staff has raised concerns of outstripping capacity to adequately care for facilities (Walkiewicz 2013). Invasive species have grown in bioswales, causing concern among designers and maintenance staff (Macy 2013; Liptan 2013). The city is currently working on programs to encourage the community to adopt some of the facilities.

8.1.6 Measurement

Participants agreed that measurements would be helpful, yet components to be measured varied. City bureaus, such as Parks and Recreation, are developing new metrics for performance reporting, and are currently addressing invasive weed treatment per year, and city tree canopy. Others voiced preferences for both perceived and actual levels of safety, access, and levels of use in areas designed to accommodate physical activity.

Respondents favored pre and post project evaluation. One emergent pattern lies in a desire to evaluate built works, comparing predesign and post design conditions. Designers indicated values associated with meeting goals of intended design objectives with regard to serving the population utilizing the physical space. Consultants noted lack of time and financial resources for such research (Macy 2013; Perry 2013).

Access to health data was a concern among respondents. One problem identified by Eric Engstrom is the availability of health data. Much data are aggregated at the county level (McTighe 2013); however, due to privacy laws, the Planning and Sustainability Bureau has experienced difficulty in obtaining information at the neighborhood level. Michael Abbaté expressed a similar concern for data pertaining to physical activity, "we have to depend on others for obesity measurement." Conversely, city planners have access to "oodles of information about transportation and travel behavior" (Engstrom 2013). Identifying sources and methods of data would assist city leaders to determine what should be measured and how.

How much green do we need? Respondents favored a more empirical approach for determining the amount of green infrastructure needed in the city. For example, goals for canopy cover have been established using "best judgment and practicality" for what is feasible (Liptan 2013). Addressing impacts of climate and existing physical conditions were identified to advance green infrastructure in the city.

Replicability of a project's best practices provides a good frame of reference. Interview participants expressed a positive association with green infrastructure and replicability of best practices. Although there were mixed responses on the use of best practices in green infrastructure, most agreed that the power of example was useful to advocate green infrastructure. "It's good to have examples in your own city when you go into a community meeting, that people don't have to travel to Amsterdam to see what we are talking about. So I think to have a shared knowledge of something is really a valuable thing in terms of communicating examples…" (Mayer–Reed 2013). Planning bureau staff expressed similar sentiments, "once we've adopted an plan and we make our infrastructure list, we usually go and implement it." Portland has a strong institutional structure that enables them to implement plans.

8.2 Project Scale Findings: Vera Katz Eastbank Esplanade

The Eastbank Esplanade transformed a derelict parcel between the freeway and the Willamette River into a vibrant link in a regional trail system. A series of improvements to bridges that cross the river–Steel, Hawthorne, Burnside, and Broadway–began in the 1990s and included measures to connect bicycle and pedestrian routes to the linear park (Birk and Geller 2006). Those connections enable bicyclists and pedestrians to visually and physically access the waterfront, creating a three-mile (4.9 kilometers) trail loop. Connecting to other trails, the park comprises a segment of the 40 Mile Loop, a regional trail originally envisioned by Olmsted Brothers in the 1904 park plans for Portland.[63] The original plan has been expanded to include 140 miles (225 kilometers) at project completion, providing connections to many destinations throughout Multnomah County. Hargreaves Associates prepared the master plan for the park in 1994. Upon adoption of the master plan, the Portland firm of Mayer–Reed was selected as the prime consultant, working on the project from schematic design to final construction documents.

[63] http://40mileloop.org

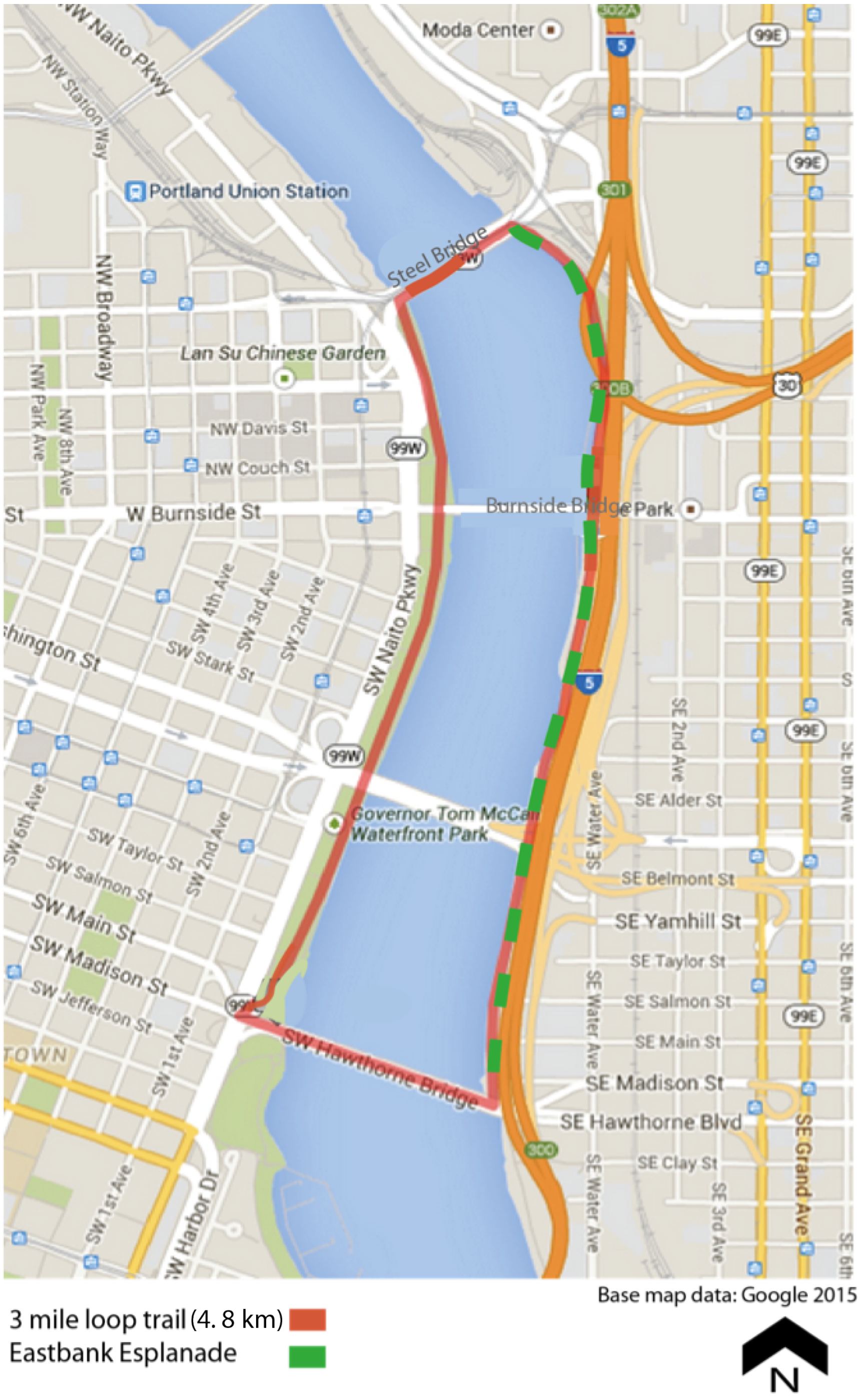

Figure 8.1 Downtown loop trail at riverfront

The master plan established a theme to reconnect the city with the river's edge "physically, symbolically, interpretively, and programmatically" (Hargreaves et al. 1998). Through simple repetitive patterns, site configuration intended to provide clarity and consistency for the narrow linear park.

Findings at the project scale illustrate the ways in which the park, within a narrow swath of land between the freeway and the river, created a successful pedestrian and bicycle trail. Challenges in permitting at the federal level impacted the project schedule, and vertical differences in elevation affected design of access ways and green infrastructure project components.

8.2.1 Green Infrastructure at Eastbank Esplanade

Site constraints limit green infrastructure to bank stabilization and tree planting. The schematic plan required native plants be used in the linear park (Hargreaves et al. 1998). One of the challenges was in the plant materials specified in the 25-foot (7.6 meters) strip between the freeway and the river, which was not conducive for optimum plant growth. Conditions called for careful selection. Some native species such as Oregon Ash were not available in sufficient size for urban installation and similar substitutions had to be made (Russnogle 2006). The understory shrubs and grasses were situated with rocks and log snags to enhance the riparian habitat, attracting insects, birds, fish, and other animals (Hinshaw 2001). These shoreline areas remain visible, but not all areas are physically accessible.

Figure 8.2 Eastbank Esplanade: shoreline area looking south

Tree species along the walkways are organized in a linear alignment for clarity and coherence, defining use areas while providing a buffer from the freeway and shade for park users.

8.2.2 Challenges to Multi-Phase Development

Federal and state regulations dictated the 'in water' portion of project construction. According to Carol Mayer–Reed, the consultant team worked on development of the project for six years. The project was divided into two major phases, with two sub-phases for each. Funding sources and federal regulations dictated the first phase of the project. The 'in-water' work was completed first, as funding was obtained from the city of Portland. This phase included the floating walkway, and its schedule was dictated by requirements of federal regulations, and river navigability. At the time of construction, both the Willamette River salmon and steelhead trout were listed as threatened species.[64] Therefore, no construction could take place during the time the fish were spawning in the river. Mayer–Reed referred to the designated construction schedule as ‘in-water-works windows.’ The upland portion of the project was a separate contract.

8.2.3 Site Audits: Evaluating Multi-functionality and Connectivity

Onsite evaluations were conducted December 13-14, 2014, utilizing the CfAD *Urban Design Checklist* to address the major park features, with particular attention given to connectivity of use areas throughout the park and to adjacent destinations across bridges to the west, and neighborhoods to the east. Destinations—such as the Oregon Convention Center to the north, and the Oregon Museum of Science and Industry Center at the south end of the park–were observed with relationship to the site. Connectivity to was evaluated in travelling both north–south and east–west initially by bicycle, and then on foot. Presence of physical design characteristics and related green infrastructure elements were identified using the Physical Design Strategies checklist. Due to the limited physical area and linear configuration of the park, the park was evaluated in a single segment. Table 8.2 illustrates the results of the CfAD audit.

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[64] https://www.portlandoregon.gov/bes/29710

Table 8.2 CfAD Audit for Eastbank Esplanade

CENTER FOR ACTIVE DESIGN

PORTLAND EASTBANK ESPLANDADE
SITE AUDIT and EVALUATION
December 13 - 14, 2015

CHECKLIST URBAN DESIGN

● *Indicates Item addressed or present on site.*
Additional comments are shown in italics.

2.1 LAND USE MIX

- ○ When Planning for urban scale developments, provide for a mix of uses - for example, residences, offices, schools, retail stores, cultural and community spaces, and recreational facilities. **Linear Trail Connects cultural and community spaces.*
- ● Locate places of residence and work near destinations such as parks, walking paths, trails and waterfront recreation areas. **Not applicable.*
- ○ Develop supermarkets and full service grocery stores near places of work and residence.

2.2 TRANSIT AND PARKING

- ○ Locate buildings and building entrances near public transit stops and along transit corridors.
- ○ Place public transit stops along well-connected streets.
- ● Provide signage at buildings, transit stops, and major intersections showing a map and the distance, time, route and calories burned to the nearest or next transit stop. **Informative and wayfinding signage for pedestrians*
- ○ Encourage transit use by furnishing transit stops with pedestrian conveniences.
- ● Make sidewalks wide enough to comfortably accommodate pedestrians, including those with disabilities **Sidewalk widths vary.*
  - □ Provide additional space for passengers to wait by adding bus bulbs.
  - □ Create bus stop shelters that protect the users from sun, wind, and rain
  - □ Furnish bus stop shelters with seating or places to lean.
- ○ When designing sites that include parking, consider how the provision of parking can affect the use of more active modes of travel such as walking, bicycling, and public transit. **Not applicable.*
- ○ Provide parking for people with disabilities **Not applicable.*

2.3 PARKS, OPEN SPACES, AND RECREATIONAL FACILITIES

- ○ Design open spaces as part of large-scale developments, or locate buildings near open, public spaces.
- ● Make bicycle and pedestrian routes to parks and public spaces safe and visible. **excellent signage for wayfinding.*
- ● When planning a new development. Aggregate open space in one large area rather than dispersing into smaller pieces. Where possible, provide residents with access to open space within a ten-minute walk. **Observed both large scale areas for gathering such as the Gre.*
- ● In the design of parks or open spaces, provide paths, running tracks, playgrounds, sport courts, and drinking fountains.
- ○ Locate new projects near existing public and private recreational facilities and encourage development of new facilities, including indoor activity spaces. **Not applicable.*
- ○ When designing offices and commercial spaces, provide exercise facilities or walking paths nearby. **Not applicable.*
- ● Design parks, open spaces, and recreational facilities to complement the cultural preferences of the local population, and to accommodate a range of age groups. **Age of range groups accomodated, cultural preferences not observed.*
- ○ Create partnerships with organizations to sponsor and maintain green spaces and gardens. **Not evaluated.*

2.4 CHILDREN'S PLAY AREAS

Portland: Eastbank Esplanade *Page 1 of 4*

CfAD Audit for Eastbank Esplanade, continued

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PORTLAND EASTBANK ESPLANDADE
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● Design courtyards, gardens, terraces, and roofs that can serve as outdoor spaces for children's play

○ When designing playgrounds, include ground markings indicating dedicated areas for sports and multiple use.
● Preserve or create natural terrain in children's outdoor areas.
● Provide lights on sidewalks and active play areas to extend opportunities for physical activity into the evening.
● In the design of parks and playgrounds, create a variety of climate environments to facilitate activity in different seasons and weather conditions.
○ Provide physical activity facilities for children and youth in schools **not applicable*
○ Design new school physical activity facilities to potentially allow for public use outside of school hours. **not applicable*

2.5 PUBLIC PLAZAS
● Create attractive plaza spaces that are well-maintained. **some wear and graffiti observed*
● Locate public plazas along popular pedestrian streets.
○ Locate plazas near transit stops.
● Make plazas accessible to bicyclists.
● Create plazas that are level with the sidewalk.
● Design plazas that allow for diverse functions.
○ Design plazas to accommodate use in a variety of weather conditions. **variety of weather conditions not observed*
○ Seek partnerships with community groups to maintain and program plazas. **not applicable*

2.6 GROCERY STORES AND FRESH PRODUCE ACCESS **not applicable*
○ Develop full-service grocery stores within walking distance in all residential neighborhoods.
○ Introduce farmer's markets as a complement to grocery stores.
○ Provide safe walking and bicycle paths between densely populated areas and grocery stores and farmer's market sites.
○ Design grocery store layouts and parking to accommodate pedestrian, cyclist, automobiles, and loading trucks safely and conveniently. Provide infrastructure such as bicycle parking a drinking fountains.

2.7 STREET CONNECTIVITY **Excellent*
● In large-scale developments. Design well-connected streets with sidewalks and keep block sizes relatively small. ** Sidewalks and multi-use paths well connected throughout the park and with adjancent areas.*
○ Where current connectivity of sidewalks and streets on a building site is poor, provide pedestrian paths through existing blocks. **not applicable*
○ Avoid creating pedestrian over- and underpasses that force walkers to change levels.
○ Maintain dedicated pedestrian and bicycle paths on dead-end streets to provide access even where cars cannot pass. **not applicable*
● Minimize addition of mid-block vehicular curb cuts on streets with heavy foot traffic.
○ Design vehicular driveways and ramps to minimize contact between cars and pedestrians.

2.8 TRAFFIC CALMING
○ Design roads to be minimum width and to have the minimum number of lanes practical.
● Incorporate traffic calming street additions such as curb extensions, medians, and raised speed reducers. **Surface differetieation on floating walkway for bicycles and pedestrians.*
○ Consider other physical design measures where appropriate, for example:
□Horizontal deflections such as curved roadway alignments 'Vertical deflections such as raised intersections or crossings
□Traffic diverters, roundabouts, and mini-traffic circles **not applicable*

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□Signal phasing plan with a protected left-turning lag phase
□"Yield to Pedestrian" signs
□Avoidance of slip lanes and wide curb radii

2.9 DESIGNING PEDESTRIAN PATHWAYS

● Create a buffer to separate pedestrians from moving vehicles using street furniture, trees, and other sidewalk infrastructure. **adjacent to limited access freeway.*
● Provide seating, drinking fountains, restrooms, and other infrastructure that support increased frequency and duration of walking.
● Provide exterior lighting along streets and outdoors paths. **street lights; path lighting in select areas*
● Include trees and objects of visual interest on streets and sidewalks.
● Make sidewalk widths consistent with their use.
● Provide for enhanced pedestrian crossings both at mid-block and at intersections.
○ Construct curb extensions along sections of the sidewalk that tend to attract greater pedestrian congestion.
● Create or orient paths and sidewalks toward interesting views.
● Provide marked, measured walking paths on sites as part of a way finding system targeted to pedestrians and bicyclists.
● Make streets and paths universally accessible. Create:
● □Paths that are smooth, sufficiently wide, and that have curb cuts and turning radii adequate for a wheelchair or walker.
□Paths with auditory crossing signals, adequate crossing time, clear signage , visible access ramps, and connections to walking, cycling and public transit routes.

2.10 PROGRAMMING STREETSCAPES

● Incorporate temporary and permanent public art installations into the streetscape.
○ Organize pedestrian-oriented programs, such as charity walks and vehicular street closures, that make wide avenues available for walking and bicycling.
○ Increase the number of outdoor cafes to enhance street activity.

2.11 BICYCLE NETWORKS AND CONNECTIVITY

● Design interconnected bikeways and establish a backbone network of unbroken through routes.
● Make links between bicycling and transit. **not evident at time of site observation*
● On bikeways, include signposts providing bicyclists with directions, distances, and times to various destinations.

2.12 BIKEWAYS

● Use on-street markings or signage to visually reinforce the separation of areas for bicyclists and motorists. **on vehicular bridges.*
● Where conditions warrant, separate bikeways and vehicular traffic lanes with physical demarcations.

○ Expand existing bikeways where use has exceeded capacity
○ Pay special attention to the treatment of bikeways at intersections and other points where the street form changes, in order to mitigate potential visibility issues and turning conflicts.
○ Avoid potential conflicts between cyclists and opening car doors - for example, by widening parking lanes where appropriate.
● Further develop Greenways - alternate routes that are integrated into the regional park system.

● Consider shared-use paths in areas with viewing attractions.

2.13 BICYCLING INFRASTRUCTURE

● Provide adequate facilities for bicyclists to park along their route or at a final destination.

CfAD Audit for Eastbank Esplanade, continued

CENTER FOR ACTIVE DESIGN

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- ● Designate bicycle-specific crossings and signals to organize the movements of pedestrians, cyclists, and motorists at busy intersections.
- ○ Construct bicycle share programs to increase access to bicycles for both city residents and visitors.
  **bike share not observed onsite.*

Based on observations from pedestrian and bicyclist perspectives, the site works well, offering trail access throughout, as well as plaza areas at critical junctures. A significant challenge was to "connect it east/west and getting access from the eastside Portland neighborhoods to the waterfront" (Mayer–Reed 2013). The east side was historically industrial, the blue-collar side of town. Part of the freeway is ongrade for a portion of the linear park, so there are places that people cannot cross the freeway (Mayer–Reed 2013). Access issues were further complicated by vertical elevation changes as much as 30-40 feet (9-12 meters) from the bridges crossing the river down to the walkways in the park.

Figure 8.3 Stair access from bridge above to the Esplanade

A series of stairs and ramps provide access, with waterfront facilities 'floating' to fluctuate with changes in water levels. "There was a lot riding on this issue of connectivity" (Mayer–Reed 2013). Lighting is provided for night use, although perceptions of safety have been questionable.

To promote physical activity, Mayer–Reed tried to separate bicycle and pedestrian traffic in specific locations. One is a cantilevered walkway where the art pieces are clustered, and steel industrial grating was to encourage pedestrian use while discouraging bicycle use. The grating provides views of the water from the walkway surface. An elevated bicycle trail was constructed in one segment to direct bicyclists to the upper pathway and allow pedestrians to descend down into the plaza. Rocks and planters were placed to discourage service vehicle use.

Figure 8.4 Separated bicycle and pedestrian paths

The Physical Design Strategy audit found characteristics contributing toward access, comfort and safety, and active engagement onsite. Table 8.3 presents a summary of site observations.

Table 8.3 Physical Design Strategies Audit for Eastbank Esplanade

Inventory: Physical Design Strategies on Case Study Projects		
City: PORTLAND, EASTBANK ESPLANADE		
12/13-14/2014		
	Indicates item is present on site	
	Indicates some items present or item not adequately represented on site	
n/a	Item not applicable to specific site	
	Indicates item not present on site	
Access		
Legibility	Ease of movement throughout activity areas in the park	
	Clearly visible and multiple access modes to the park	
	Respectful of terrain	
Coherence	Separation of Traffic Modes - car, bicycle, pedestrians, transit	
	Aggregation of open space in large central area	
Tidiness	Trails with good surfaces	
	Provision for areas made for sun in winter, shade in summer	
Connectivity	Trail connections to offsite trails and parks	
Context	Neighborhood access encourages park use*(2)	
Comfort and Safety		
Legibility	Safe and visible pedestrian and bicycle routes within the park	
	Benches	
	Restrooms - location and proximity to use areas	
	Drinking Fountains - location and proximity to use areas	
Coherence	Lighting on Trails and Activity Areas for Extended Use	
Complexity	Effective Use of Native Materials, establishment of identity	
Tidiness	Condition of Facilities and Equipment	
	Little or no evidence of debris, litter	
Active Engagement		
Legibility	Centrally visible activity spaces	
Context	Proper orientation for sports courts, etc.	n/a
	located for shared resources)	
Diversity	Multiple facility types and uses provided	
	Flexible Open Space Provided	
Complexity	Facilities co-located to optimize simultaneous p/c activities	
	Motivational decision prompts placed to encourage mobility	
	Curvilinear roads and paths	
Connectivity	Connection to multi-use paths	
	Marked distance trails	
Discovery/Fun		
	Different Experiences created for road and path users	
	Create or preserve natural terrain in children's play areas	
Green Infrastructure Elements/lands		
Park		
Open Space		
Stormwater Management Areas		
Street Trees/street right of way		
conservation area		
other		
urban agriculture/fruit trees		
native prairie habitat		

The spatial configuration of the site encourages movement in its legible and well-placed signage, oriented for bicyclists and pedestrians. Signage oriented for both pedestrian and cyclists indicate distances along the route, as well as to destinations beyond the park. Multiple facilities are limited by physical space in the park, and different experiences appear to have been created for pedestrians and bicyclists, as well as providing aesthetically pleasing views of downtown on the west side of the river. The park has no restrooms, and most drinking fountains were operational. Some graffiti was observed in walkways under the freeway.

8.2.4 Public Health Considerations

Project interface with public health considerations was limited to water quality issues. Based on interview responses, interaction between the project team and the health department focused on water quality. The site plan proposed access to a seasonal beach between the Hawthorne and Morrison Street bridges. The connective walkway was deleted from the plan after to create a connective walkway to it. Material testing of sediments prohibited that water quality not good enough for human use. Mayer–Reed expressed concern over healthy design, “We want to create good, healthy, safe places that people get in the habit of using.”

8.2.5 Power and Collaboration

Permit challenges were driven by federal agencies, species of concern, and navigability. Based on interview discussions, permit challenges escalated immediately after design development for the project began. Two more species of concern were added to the ESA list. Implications were contemplated for the floating walkway portion of the project. At that time, the project was granted permission from USACE and the Portland Harbor master to construct the walkway so as not to interfere with the navigable waterway. To address species of concern, a study was commissioned to assess the potential impact of bottom shading in the river on fingerling salmon. Multiple agencies were involved in the process: "every agency you can think of weighed in, but the federal and state [permit] package comes together so that you're dealing with the agencies as a group " (Mayer–Reed 2013). The streamlining of the permit process assisted in the critical timing of project construction.

Seismic concerns prohibited structures underneath the freeway. Early planning concepts envisioned structures to be built under the freeway adjacent to the cross streets, yet seismic concerns prohibited construction. (Mayer–Reed 2013).

Union Pacific Railroad agreement for the Steel Bridge was a monumental task. The Hawthorne Bridge on the southern terminus of the project facilitated pedestrian and bicycle circulation, yet the Steel Bridge was needed to complete the northern river crossing for the loop trail. The agreement with the Union Pacific Railroad was executed to allow construction the Steel Bridge Riverwalk, which is attached approximately 30 feet above the Willamette River. [65]

Effective project team collaboration contributed to project success. According to project director Mayer–Reed, the project team worked well together; environmental consultant provided valuable input on fisheries and habitat, and structural engineers made the designs seaworthy.

[65] http://www.portlandoregon.gov/parks/

8.2.6 Maintenance Considerations

Use of native plant species was challenging along the river. Portland Parks and Recreation operates and maintains Eastbank Esplanade. As previously stated in the discussion of design considerations, using native species provided challenges in the narrow corridor along the river. No specific maintenance challenges, however, were identified relative to plant species.

Effects of homeless camps have obstructed access from side streets east of the park. Encampments were observed at the eastern boundary of the park, near Hawthorne and Morrison Bridges.

Figure 8.5 Homeless encampments near eastern park boundary

8.3 SUMMARY

Portland's reputation as a national leader in stormwater technology and application has been instrumental in the transformation of green infrastructure from an amenity to a necessity. Many examples now exist to demonstrate both effective and economical solutions toward the goal of watershed health. As utility rates support green infrastructure stormwater efforts, facilities include opportunity for physical activity as ancillary uses. Primary uses for physical activity remain in the realm of parks and recreation, as well as active transportation.

Municipal plans reviewed illustrate an established hierarchy from broad goals and objectives in comprehensive plans, to a more fine-grained interpretation with actions items for implementation guided by strategic plans. Silo based bureaus and limitations on funding continue to challenge effective approaches to system wide improvements. Mechanisms are still dependent on scale and extent.

The Eastbank Esplanade Park transformed a derelict remnant of land between the freeway and the river into a vital link in both the downtown and regional trail system. Challenged by federal regulations for endangered species and navigability, the project team responded with a legible and well-organized contribution to the reclamation of Portland's waterfront.

Chapter Nine: Synthesis and Implications

Although approaches to green infrastructure and physical activity in each of the four cities reflect the unique character of both the signature project and municipal structure, common themes and patterns have emerged. Chapters Five through Eight identified findings in response to the research question and respective sub questions in Austin, Denver, Louisville, and Portland. This chapter presents a summary of the findings and analysis of patterns across cities at three critical levels. These include projects, municipalities, and a larger movement of broad overarching themes. In this chapter I begin with a brief overview of the study in terms of the statement of the problem, research question, and methodology. Then, in the next three sections I present a synthesis of findings and analysis, both those consistent with existing theory and literature, as well as unanticipated patterns. Final sections address implications for action, recommendations for future research, and concluding remarks.

9.1 Study Overview

Cities depend on ecosystems to support long-term conditions for human health (Odum, E. 1989). Healthy city planning has become a new way of thinking about urban growth and development, shifting away from a response to mitigate hazards to a more proactive stance of prevention and precaution (Corburn 2009). To sustain health and support growth, adequate physical infrastructure serves to address, in part, chronic health problems caused by physical inactivity. This study focuses on physical infrastructure in the promotion of health through access to and facilities for human physical activity.

The elevation of green infrastructure from an amenity to a necessity equivalent with conventional gray solutions (Wright 2011) in the United States is largely attributed to stormwater regulations emanating from the Clean Water Act (1972), and the Clinton Administration's report for sustainability (1999).[66] Federal stormwater regulations have placed significant responsibility on local governments for water quality improvement and management, while the Clinton report emphasizes green infrastructure as a goal for place-based strategies for livable communities. Through an assessment at the project scale, my research explores strategies to improve the integration of biophysical and cultural components of urban ecological infrastructure through community design. The principles of multi-functionality and connectivity offer promise not only for stormwater management solutions, but also for promoting opportunities for physical activity.

My central research question is how can green infrastructure serve as a bridge between planning and public health to realize infrastructure that provides opportunities for physical activity at the municipal scale? Four thematic questions are posed relative to the central research question in dimensions of scale, health, power and collaboration, and measurement. From the perspective of critical pragmatism, normative planning, urban ecology, and good city form largely constitute the theoretical framework. Communicative action and interdisciplinary interaction contribute to the research approach.

The study contains two levels of analysis. A signature project in each city provides a context in which to evaluate municipal plans and procedures relative to green infrastructure and physical activity. Methods employed are generally based on qualitative procedures, incorporating three types of investigation. These include: 1) an evaluation of municipal plans (comprehensive plan, and citywide plans for parks and recreation, stormwater management, and green infrastructure/greenprinting) for fact

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[66] http://clinton2.nara.gov/PCSD/Publications/tsa.pdf.

base, proposals, and implementation relative to green infrastructure, health, and physical activity; 2) evaluation of project scale plans, and field work using two audit forms to identify and assess implementation of principles including integration, connectivity, and multi-functionality; and 3) 44 semi-structured interviews with key participants in the regulatory process and professional consultants responsible for the planning and design of signature projects, combining storytelling and empirical knowledge to better understand the issues and the context in which they occur. Each project relies on the institutional framework of its respective city to highlight issues of scale, health, power and collaboration, and measurement.

9.2 Project Scale Synthesis–Physical Spaces

While signature projects were evaluated individually, several patterns emerged common to all projects. I present them here in two dimensions, those findings expected from literature reviewed, and those that emerged as unanticipated patterns.

9.2.1 Findings and Analysis Consistent with Literature Reviewed

Based on evaluation of data collected, each project consists of a well-thought out master plan that clearly delineates goals and objectives for implementation. These multiple phase endeavors experience an extended maturation for build-out, in duration of several years. Timing of phased construction activities often delivers interim challenges for connectivity, as observed in pedestrian circulation at Mueller and in the physical sequencing of construction at Waterfront Park, where the end sections of the park were developed before the central connecting piece. Phased development also enables the project team and key participants to learn from the successes and failures of initial construction efforts. The process employs a reflection-in-action (Schön 1983) approach in which the project team works to solve problems during successive design iterations, citing precedents from both initial phases and other projects. For example, inlets along the Ohio River constructed in Phase I of Waterfront Park created difficulty in project maintenance and were deleted from subsequent phases of the project (Pepper 2014). Road widths at Lowry were reduced from 32' to 30' (9.75 to 9.14 meters) in later phases after the developer demonstrated the benefit of alleys, reducing impervious area of the wider streets (Stern 2006; Arbogast 2013). In this way, the early work sets precedents within each project. Additionally, this iterative approach allowed reflection of action from previous phases toward creating new knowledge to be applied in future projects.

Connectivity was well documented in project plans for both pedestrian and bicycle circulation, as well as observed in site analysis. Values expressed in master plan goals and objectives are reflected on the ground in project site configuration and path sequencing. Lynch's ideas for good city form (1981), particularly dimensions of legibility, were identified in each project. Off-site connectivity extends beyond Waterfront Park and Eastbank Esplanade in the form of a broader trail network, but was not as visually or experientially apparent in Mueller or Lowry.

Master planning in each project allowed for the aggregation and integration of green infrastructure with other ecosystem services, as well as with conventional gray infrastructure. Combined use areas for stormwater management, recreation, and wetland areas for habitat improvement illustrate multi-functionality within the projects. The two mixed-use projects employ a cohesive strategy of aggregating infrastructure in both master planning and construction sequencing–streets, stormwater detention, potable water, wastewater, reclaimed water and water quality components–that allowed a compact configuration of residential and commercial land uses, combining open space as an on-site system. Findings suggest this successful integration realizes urban ecological infrastructure with biophysical and cultural ecosystem services (Pauleit et al. 2011). The focus on ecological principles, rather than varying definitions of green infrastructure, is consistent with my argument that crafting a single definition for green infrastructure is unnecessary, and concentrating on operationalizing green infrastructure principles works toward effective solutions. Successful precedents contribute to advance green infrastructure in both theory and practice.

The signature project in each city gained recognition for innovative solutions through receipt of numerous awards and accolades. The projects were clearly referenced in municipal plans, as: models for compact and connected growth in Mueller; areas of change at Lowry; a vital visual and spatial re-connection to the Ohio River in Waterfront Park; and in Eastbank Esplanade a critical link in the downtown trail system for both recreation and active transportation. These works represent a snapshot in time with long-lasting implications (Ryan 2011). Each project articulated goals of a well-thought out master plan and strategies for development, yet faced institutional misalignment translating scale and in receiving approval at critical junctures in the regulatory process.

The two urban infill projects–Mueller and Lowry–overwhelmed municipal agency review in both magnitude and accelerated schedule (Stern 2006; Force 2014). Mueller violated over 100 code regulations in its proposal for Planned Unit Development (Hefner 2013). Each project experienced challenges to innovative solutions: bending the rules, breaking the rules, and in some cases, making new rules. The misalignment may be attributed, in part, to what Elisabeth Hamin (2006) refers to as a mismatch between the broad visionary goals of a comprehensive plan, and the minimum requirements to be met in conventional zoning and subdivision requirements.

Even with such challenges, the projects serve as models for others. Prior to development, representatives from Mueller visited Lowry to learn from both project successes and failures (Hefner 2013), and Lowry set precedents for residential green building and use of native vegetation in its open space system, which was improved upon and expanded in nearby Stapleton (Arbogast 2013; Grote 2013).

9.2.2 Findings and Analysis–Unanticipated Patterns

In discussion with public health agency personnel across the four cities, incorporation of health into comprehensive plans (City of Austin 2012), as well as the issuance of health plans (City of Denver 2011; Metro Louisville 2014), advance several goals and objectives for human health, including physical activity. In Louisville and Denver, health impact assessments had been conducted on trail projects adjacent to the signature projects, promoting physical activity (Sizemore 2013, Searns 2014). Conversely, the public health approach with regard to the four signature projects was largely in response to mitigating environmental hazards resulting from previous land use practices. My expectation had been that the plans would have incorporated proactive approaches for health promotion. This may be attributed to the temporality of plans. In recent history, health was largely expressed in municipal as terms of recreation and walkability (City of Austin 2011; City of Denver 2003; City of Louisville and Jefferson County 1995). Corburn (2009) recognizes this shift as one from a reactionary to proactive approach to planning for health.

Another unanticipated pattern at the project level suggests types of development may be influenced by regulation at different levels of governance. Based on review of plan approvals and interview responses, the mixed-use projects of Lowry and Mueller encountered difficulty at the municipal scale, while the waterfront park projects–Waterfront Park and Eastbank Esplanade–were more challenged by regulations of federal and state agencies for flood control, waterway navigation, and presence of threatened or endangered aquatic species.

9.3 City Scale Synthesis-Conceptual Spaces

Patterns across cities address perceptions of green infrastructure, relationships between physical activity and green infrastructure, existence and influence of disciplinary silos, project collaboration, maintenance, and measurement. Findings are presented first as those expected from review of existing theory and topical literature, followed by patterns that were not anticipated.

9.3.1 Findings and Analysis Consistent with Literature Reviewed

According to review of data collected across cities, perceptions of green infrastructure appear to be generally positive. Municipal documents, however, were inconsistent in use of the term ‘green infrastructure.’ Partially attributed to consistency with terminology in Texas Parks and Wildlife Department documents, the *Austin Parks and Recreation Long-Range Plan for Land, Facilities, and Programs* (2011) principally refers to open space and greenways, rather than green infrastructure. Portland’s series of park plans fail to reference the term until its *Five-Year Implementation Strategy 2012-2017* (2012). Louisville’s *Cornerstone 2020* plans that were completed in the 1990s contain no specific references to green infrastructure. Yet the Louisville *Stormwater Management Plan* (2010) makes extensive references of green infrastructure concepts, operationalization of concepts, and implementation strategies in terms of best management practices. Findings appear consistent with disciplinary definitions (Wright 2011; Benedict and McMahon 2006; Kambites and Owen 2006), in which each definition responds to the interests and specializations within particular disciplines and professional interests. This pattern suggests that both time of plan completion and disciplinary objectives may influence how and where the term is employed.

A positive relationship between green infrastructure and physical activity was found to be consistent among interview participants. Its meaning and interpretation, however, varied among cities. Respondents in Denver cited variations in levels of support among departments; in Portland, the ancillary relationship of physical activity to green infrastructure was discussed. Funding sources dependent on utility fees affect priorities for green infrastructure projects (Engstrom 2013), and limit what types of green infrastructure for physical activity may be combined with stormwater management. Such results challenge the trajectory toward a holistic approach to green infrastructure.

In addition to limitations of funding sources, disciplinary silos challenge integration of urban ecological infrastructure in both planning and implementation. In their pioneering work on green infrastructure, Benedict and McMahon (2006) recognized the tension among land uses and disciplinary interests in attempts to achieve an integrated balance. A pattern of disciplinary silos across the four cities emerged between agencies that acquire and manage lands (public works, parks, watershed protection) and those who do not, such as planning (DiGiuseppe 2013; Abbaté 2013; Stump 2014; Heitz 2014). Institutional structure and goals of different departments suggest little movement toward holistic solutions. While best practice examples address design and implementation at the project level as illustrated in the four signature projects, few studies examine green infrastructure planning in practice (Lafortezza et al.

2013) at the municipal scale. *Imagine Austin* (2012) has stimulated interdisciplinary collaboration through formation of interdepartmental groups to address critical issues (Adams, G. 2013). The task teams formed for green infrastructure in 2013 identified a 'wish list' of action items, but results were not readily available during data collection period for this study. One respondent summed up the problem as "a tug of war" at mid and upper level management among professional disciplines (Stump 2014). In Portland, a planner lamented that no one is accountable for the 'big picture.'

Interview participants cited collaborative efforts as being more successful at the project level, rather than at a municipal scale. Seeking solutions to common problems describes the design process, where project team members think in action (Schön 1983), proposing strategies utilizing knowledge from previous experience with context specific information. Benefits accrue from the exercise of working across disciplinary lines (Hack 2015). Faced with shrinking municipal budgets, Portland's active transportation and stormwater management bureaus established synergy, combining objectives into multiple functions to obtain the resources to complete projects (Engstrom 2013). Similarly, continuity in team participants across disciplinary boundaries has forged alliances in successive and long-term projects, such as the Louisville Loop. Little evidence surfaced in support of more holistic citywide solutions.

Precedents were also found among the cities in development of municipal plans. In preparation of its *Water Quality Management Plan* (2004), Denver staff members reviewed national case studies in several cities, including Portland, Oregon and Austin, Texas.

9.3.2 Findings and Analysis–Unanticipated Patterns

Each of the four case study cities received CDC grants, in the form of CPPW (2010-2012) and CTG (2011-2014) funds,[67] contributing in part, toward active living programs. In Austin, funds underwrote two planning positions to more fully integrate health into Austin's planning department (DiGiuseppe 2013; Larson 2013). Louisville Public Health and Wellness engaged other departments, partnering efforts with funding for such items as signage for the Louisville Loop and the Mayor's Hike, Bike and Paddle annual event. In Denver, CTG funds contributed to park development (Wierczorek 2013). Availability of funding sources in support of physical activity enabled cross-departmental collaboration.

The politics of maintenance arose throughout discussions with interview participants. A reluctance to change maintenance practices evolved from a lack of equipment required and absence of expertise. Long-term agreements created public private partnerships to maintain open space in both Lowry and Mueller (Austin 2013; Force 2014), providing potential models for other projects as well as other cities. This illustrates Flyvbjerg's 'power of example' (2001), where the power of the project works to shape outcomes at the municipal scale.

Louisville relies on WDC for complete maintenance of Waterfront Park, while Portland divides green infrastructure management and maintenance between the Bureau of Environmental Services (BES) and the Portland Parks and Recreation Bureau (PPR). BES oversees stormwater aspects, while PPR assumes responsibility for the tree component of green streets and urban forestry (Abbaté 2013). The study of maintenance practices and responsibilities is needed as technical and innovative green infrastructure solutions continue to evolve across cities.

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[67] http://www.cdc.gov/nccdphp/dch/programs/

An important contribution in the evolution of green infrastructure lies in the recognition of benefits that human populations gain from ecosystems. One strategy to document this recognition involves measurement of such benefits. The quest for metrics has taken different forms. In recent years, the 'sustainable' comprehensive plan addresses a more integrated approach to achieve more sustainable solutions to growth and development (Godschalk and Anderson 2012), including identification of key performance indicators. 'Green' project certification programs such as the Sustainable Sites Initiative (SITES)[68] and Leadership in Energy & Environmental Design (LEED),[69] offer systematic rating systems based on voluntary guidelines that measure project performance of healthy functioning landscapes and buildings. One of the problems associated with establishing goals for ecosystem services lies in the difficulty of direct measurement of many of the services (Windhager et al. 2011). Based on interview data, there were mixed reactions as to what elements of green infrastructure should be measured, and questions as to how they should be measured. Development of components to be measured as well as data collection methods and metrics appear to be in a nascent stage at the municipal level, with inconsistencies in access to and availability of data. Interview respondents voiced concerns of access to data. Little evidence was found offering guidance in development of municipal scale metrics and methods.

Another unanticipated finding involves reluctance to widespread application of best management practices (BMPs). During the early years of NPDES compliance, resistance to innovative BMP solutions was evident, and contradictions identified in the regulatory process (House Subcommittee 2007). Over time BMPs have been adopted

[68] www.sustainablesites.org
[69] www.usgbc.org/leed

with the intention to advance green technologies and practices. Yet respondents expressed concern for limitations and misuse as attachments rather than integral components to design. Misuse in a ‘cookie cutter’ approach, what fits in one neighborhood, does not necessarily fit in another (Perry 2013). Participants suggested flexibility in use of guidelines rather than rigid standards.

Anticipating a transdisciplinary approach based on literature in both green infrastructure and physical activity, findings were not consistent with literature reviewed. Some evidence of interdisciplinary approaches in project endeavors and problem solving emerged, but scant transdisciplinary collaboration among academic and non-academic interests was identified, with two exceptions noted. One involves a collaborative effort between Louisville’s Municipal Sewer District and the University of Louisville to develop stormwater green infrastructure projects on campus. Secondly, the establishment of native prairie landscape in the Southeast Greenway at Mueller demonstrates a combined work effort among master developer Catellus, project landscape architect Barbara Austin of RVi Austin, and The University of Texas affiliated Lady Bird Johnson Wildflower Center. Further study is needed to explore the dimensions of interdisciplinary and transdisciplinarity as related to both research and practice in green infrastructure and physical activity.

9.4 THE BIG PICTURE: A LARGER MOVEMENT OF OVERARCHING THEMES

The signature projects test rules and requirements within a municipal regulatory framework. All reclaimed derelict land and repurposed land uses in cities celebrated for green strategies in both municipal planning and implementation. My study is situated through a lens of critical pragmatism, focusing on both processes and outcomes within a normative framework. On a broader scale, movement from knowledge to action resides in three domains: navigating through a messy process influenced by both disciplinary silos and collaborative efforts; a temporality of plans in time and space; and the value of storytelling and critical pragmatism in knowledge production.

9.4.1 Normative Theory and Green Infrastructure

The municipal planning process operates within a normative framework that anticipates an orderly and prescribed process. Normative theory prescribes, "the relationship between the variables in question should be in order to produce results that are deemed desirable" (Brooks 2002, 22). My research employs an ethical normative framework–what is desirable in the context of an external principle. I argue that green infrastructure as a multi-functional landscape fosters public health in providing opportunities for physical activity. Normative goals reflect the ethics of planning through attitudes and values (Rouse and Bunster-Ossa 2013), which in turn shape design of green infrastructure in various applications. In other words, concern for design in planning reflects normative planning goals (Anselin et al. 2011). Although the regulatory process offers a solid framework, there seems to be something missing in effectively translating the vision of broad goals for a healthy city from concept to reality. My findings suggest the breakdown of in the process rests, in part, within the disciplinary silos that represent departmental goals and objectives, and reluctance to readily embrace new ideas when faced with inadequate resources and technical knowledge to implement innovative and sustainable solutions.

I situate my research within a normative framework for two reasons: in practice, that is the process generally followed to take projects from concept to fruition; and secondly, research in normative planning needs to address the relationship between planning and design with respect to the opportunities and challenges experienced in the plans approval process. In this way, improved outcomes for green infrastructure may advance practice and inform theory.

Each project demonstrated a sound structure geared for success: a well-thought out plan involving interdisciplinary collaboration; continuity in project team members throughout multiple project phases, as well as public and private interests partnering to realize the project values and goals through its implementation. In advocating a commitment to good city form, the regulatory framework seems to lack what Talen and Ellis (2002) refer to as "clear, durable standards for successful outcomes." Additionally, strategies for realizing urban ecology's contribution to urban design in its attention to form and detail appeared to be hampered by a messy and inflexible process.

9.4.2 Messiness, Innovation, and Collaboration

The rational planning approach taken by Brooks (2002) generally represents conventional planning practice. One of the pitfalls of normative theory in practice resides in its lack of appreciation of the complexities involved in planning and design, challenged in part by the respective roles of planners and designers.

Planning as a discipline emerged from design in that early educators and practitioners were landscape architects (Steiner 2011b, 213). Since its historical focus of strong centralized physical planning, planning has shifted away from physical planning toward the social sciences (Campanella 2011; Steiner 2011b). This movement has diversified the field largely in two camps: as a process based discipline, or "a physically oriented search for ideal urban form" (Anselin et al. 2011, 197). In recent years, recognition that planning practices result in implications for physical design has raised concern that planning focused more on process than improved outcomes. In his seminal work *A Theory of Good City Form* (1981), Lynch described the tensions in planning being attributed to a lack of integration in how planning decisions were made, how form can be predicted, and what good form should be. The legibility of a landscape, particularly in its clarity for wayfinding and directing movement, is illustrated through design. Policy and physical planning contribute toward that effort through both municipal comprehensive plans and guidelines for design.

Design involves a problem solving process in which there is a response to a set of existing conditions (a problem) to which a new set of conditions (a solution) would be more desirable. Aspects of the environment that should be included in design involve form; order; functionality in the spaces that facilitate various uses; movement through space and time; context, in that form and meaning must be connected; and aesthetics, creating spaces of beauty (Ching 2007; Vroom 2006). In making design decisions, project team members interact to solve problems toward the goal of bringing a concept to fruition in a particular context at a specific location.

The signature project tests the regulatory framework in its aggregated approach to multi-functional landscapes as components of ecosystem services. Faced with what Vasishth and Sloane (2002) refer to as the artificiality of multiple and often overlapping jurisdictional and agency boundaries, project consultants navigate through a messy process for project approval and implementation. Bureaucratic land use controls affect urban form and ecological infrastructure, indicative of the differences in institutional and ecological scales (Millennium Ecosystem Assessment Framework 2003). Findings suggest a lack of consistency between the innovative projects and the regulatory framework in which they occur. The visionary goals of planning are influenced at critical junctures in the process by other disciplinary interests and priorities, constricting the flexibility that Lynch (1981) called for to achieve good urban form. As Ryan (2011) argues, "innovation is highly valued in design, but it occupies little space in contemporary planning discourse" (325). In an OLIN presentation on the intersection of planning and landscape, Australian landscape architect Richard Weller supports the position, stating, "[Although] planners...are the ones pulling many of the strings behind the scenes that ultimately lead towards much of the work we designers produce, they have struggled with the ability to deliver creative intelligence into design" (Dawson and Jones 2013). There exists a need to further explore the value of innovation in design and how the relationship of planning and design can better address ways in which invention can be embraced to advance new solutions for urban ecological infrastructure through collaborative efforts.

Innovation combines creative thinking and logical thinking in an effort to separate good ideas from bad (Forsyth 2007). Rather than relying solely on single discipline solutions, innovation is sometimes a translation from one discipline to another, such as contributions from urban ecology to landscape architecture; or collaboration among disciplines (Forsyth 2007). It looks purposefully beyond a single site and sole profession, and is realized in the interdisciplinary efforts of signature projects. Fresh perspectives and creative approaches characterize the signature projects. My findings suggest that disciplinary silos and restrictive codes and rules, however, sometimes challenge these perspectives.

Disciplinary silos limit cross-disciplinary collaboration. Green infrastructure as a process addresses multiple scales: local, regional, state and national (Benedict and McMahon 2006). Although references to green infrastructure appear in municipal plans, translation of scale from site to city was hardly apparent within departmental master plans. The absence of a comprehensive framework strongly suggests there is no overarching plan or process for aggregation and integration of urban ecological infrastructure. Each agency generally assumes responsibility for a particular component of a multi-functional landscape, such as: stormwater management; conservation; parks, and open space. Advancing green infrastructure has experienced some success at the project level in demonstrating the principles of multi-functionality and connectivity, yet scant evidence was found at the municipal level. Strategies are needed for integrating efforts among agencies to enable aggregation of urban ecological infrastructure and enhance awareness of the role that ecosystem services may serve in working toward a goal of the healthy and sustainable city.

Planning literature for collaboration largely relies on foundations in communicative action, in which common understanding associates coordinated actions in reasoned argument, cooperation, and consensus (Habermas 1984, 86). According to Healey (2010; 2012) communicative action emanated from "experiences of practical action and experimentation" (2012, 334) and quest to develop strategies for the evolution of new ideas. One of the criticisms of communicative action was its failure to acknowledge the role of power in the process, favoring consensus over conflict. Innes (1995) advanced collaboration concepts as a way to guide problems and drive collective decision-making.

My findings suggest that this collective decision-making has been employed in two ways. First, at the project design scale, collaboration among project team members worked to solve encounters typically faced as part of the design process. Secondly, collaborative efforts at the project level were necessitated by the complexity and conflicts surrounding municipal regulations in innovative proposals and aggregation of infrastructure.

In effect, I argue that a lack of flexibility in the rules and regulations required for project approvals resulted in additional collaboration efforts. Healey (2003) describes the necessity of collaborative efforts similarly, as a contest of 'bottom up forces' resisting and reworking 'top down policies,' within a broader context of other 'driving forces.' Differing approaches to the daylighting of Westerly Creek at Lowry led to conflict among participants in both the project team and municipal partners. Caught in a stalemate to move forward with a multi-functional open space, consensus could not be reached through collective decision-making. The path of escalation engaged the LRA director and top-level staff in the mayor's office to strike an agreement consistent with project master plan goals and objectives. Collaborative theory only works in practice when participants willingly work together to solve problems. Lynch (1981) suggests that a lack of understanding of culture and politics works against the establishment of good urban form. As both a planner and architect, Lynch built his image of the city by crossing the boundaries of planning and design. The interdisciplinary consultant teams in the signature projects collectively collaborated to cross boundaries for collective design decisions. The disciplinary perspectives and missions of each department sometimes work to obstruct innovative solutions. More flexibility in regulations, and streamlining of the process (as in the state and federal concerns for endangered species in Portland's Eastbank Esplanade) may work to advance green infrastructure that promotes physical activity.

9.4.3 Temporality of Plans and Contradictions of Scale

According to Hopkins (2001) plans function as tools by which decisions are made in uniquely local circumstances. Methods employed in this study evaluated plans based on fact content, policies relative to green infrastructure and physical activity principles, and implementation strategies. To understand the context of the plan and its influence on decisions made at the municipal scale, it is important to consider the social and political values at the time the plan is produced (Ryan 2011). Timing may affects terminology used, as well as the political climate and context of what is happening from cultural perspectives. Enabling state legislation influences and/or directs the content of the plans in the four case study cities, yet the timing in terms of values and context of what was happening politically and socially suggests an influence affecting the outcome of decisions of projects and priorities.

Another influence in plans and decision-making was evidenced between the scales within the institutional structure. Lowry's Westerly Creek dilemma notwithstanding, patterns suggest collaborative efforts yielded favorable results at the project scale. Supporting effective collaboration was the consistency and continuity among project teams in each signature project. As Steve Sizemore related in his experience with the Louisville Loop, project team members had been meeting monthly to discuss common issues on the projects, providing an opportunity not only to discuss the Loop, but also to initiate discussion on other projects and common interests shared among participants. Moving up the scale, more participants with differing agendas exist at the municipal level. The situation was summarized by Denver parks planner Mark Tabor: "It gets crazy because the complexity and the missions of the various departments, they are pretty myopic…collaboration is a lot harder than just being focused on your objectives." This suggests collaboration may require different approaches based not only on participants but also at particular levels of institutional scale.

9.4.4 Storytelling and Critical Pragmatism

Case studies have been widely used in the urban planning and design professions through written and visual documentation of projects as a method of storytelling to communicate knowledge and advance theory (Francis 2000, 1999). Case studies have been employed in both academy and practice as a process to document the successes and failures in design projects. In practice, case studies suffer from two types of criticism. Few practitioners conduct post occupancy evaluations to document attainment of design objectives; even fewer clients may be willing to pay for such post design services. When evaluations are completed, Francis cites a lack of analytical rigor by practitioners. Secondly, those case studies are sometimes presented as anecdotal "war stories" (Windhager et. al 2011). This study intends to present a more formalized approach to demonstrate the use of the case study method to improve design practice through post-occupancy evaluation. The stories of actors involved in the process inform both site analysis and the municipal planning framework.

In this study, stories worked to help reconstruct "selectively what the problems at hand really are" (Forester 2012, 195). Stories from individual perspectives of participants involved in the process documented not only what happened, but the feelings and values associated with it-the disillusionment when broad policies restrict new technologies in the case of pervious pavement; the frustration experienced when conflicting goals result in a path of escalation as described in the Westerly Creek open space network; the sense of accomplishment at Mueller when the city of Austin and Catellus finally worked through the 100+ code violations to approve the master plan, setting in action a plan to revise the land development code.

Consistent with Forester's observations of learning from practice stories (2012), storytelling associated with the process and projects revealed information about how power and rationality interact. The vision of the healthy sustainable city appears to be contested by the agency silos of those who acquire, manage, and maintain land. Critical reflection of these stories and experiences allow us not only to advance from knowledge to action, but also to go further toward completing the cycle where knowledge prompts action, and then action is analyzed to create new knowledge. While every project is different, the contextual knowledge and patterns that emerge offer knowledge to advance green infrastructure in both academy and practice.

9.5 Implications for Action

The takeaway for practicing urban planners embraces the role of planner as catalyst, in which the planner works to find the best fit, determining what types of knowledge are appropriate to a particular situation, reflective of values and available resources (McHarg 2006). An interdisciplinary approach strives to understand the perspectives and expertise across the municipal spectrum, as well as the obstacles in terms of rules, funding sources, and objectives toward implementation of incorporating healthy city initiatives and practices. Another important part of the solution exists in the reading of plans (Ryan 2011) to gain a better understanding of meaning: not only how plans are used and interpreted by planners, but also how plans are interpreted by those who utilize them in other parts of the process (310), such as design and permit approvals.

To foster green infrastructure that promotes public health, I offer the following actionable recommendations:

1. To develop a better understanding level of how green infrastructure is situated in municipal planning, conduct training for city employees specifically for the comprehensive plan and land development code. This

type of training program was initiated in Austin for the *Imagine Austin* comprehensive plan. Employee training was commensurate with responsibility in implementation of the plan: awareness, understanding, and working levels.

2. Conduct inventory and evaluation of existing municipal open space using GIS data to assess equitable distribution throughout the city. Identifying gaps can work to develop strategies through acquisition or easement agreements to realize additional open space.
3. Conduct a municipal tree canopy inventory as the first step in projecting future needs for tree canopy in support of reducing heat island effect, and increasing nature contact. The city of Louisville initiated a tree canopy inventory in preparation for projecting the percent canopy that would be needed to reduce the city's heat island effect. As opposed to targeting a number of what a city could attain, evaluation of existing inventory provides an empirical basis for assessing needs.
4. Develop strategies for green infrastructure maintenance. As green infrastructure technology evolves and the application of green infrastructure for stormwater management, street trees, and native habitat areas increase, maintenance of green infrastructure remains critical for long term success. Models developed in Lowry and Mueller for public/private partnerships for open space maintenance offer examples to adapt in other locations.
5. Develop criteria in plans approval checklists at the municipal level to support innovative green infrastructure that supports public health.

Flexible criteria may encourage more creative solutions for advancing green infrastructure in practice.

In response to my research findings, I recommend the following actionable items in support of green infrastructure that promotes physical activity:

1. Collaborate among city departments to optimize green infrastructure for physical activity. In Portland for example, departments combined financial resources to implement green infrastructure projects incorporating both stormwater management and recreation.
2. Acquisition of public land that is equally distributed throughout the city creates a challenging, if not impossible task. In both the interim, as well as long term, city leaders and those charged with providing infrastructure for physical activity need to look beyond green infrastructure for feasible opportunities. Events such as Louisville's hike, bike, and paddle involve temporary street closure to provide for physical activity. Programs such as Sunday streets and Ciclovia events utilize temporary street closures to allow for physical activity. Originally conceived in Bogotá, Columbia, events have been held in Austin, Denver, Portland, and Louisville. Sunday Streets, sponsored by the City of San Francisco, provides safe outdoor spaces for physical activity distributed in neighborhoods throughout the city.
3. Incorporate objectives and strategies from the National Physical Activity Plan, as well as state physical activity plans, into municipal plans and processes to more fully integrate health policies. While local public health

departments reference the CDC Community Guide (2008),[70] environmental and policy approaches to increase physical activity as referenced in the Guide need to be incorporated into municipal comprehensive plans and city wide plans for transportation, parks, and watershed protection/stormwater management. Both city planning and design agencies, as well as professional consultants, need to attain a working level understanding of Community Scale Urban Design Land Use Policies as well as Street Scale Urban Design Policies.

4. Convene meetings among parks, public works, and watershed protection/stormwater management departments to streamline efforts to link networks combining gray and green infrastructure for pedestrian and bicycle connectivity. Austin's *Urban Trails Master Plan* and *Denver Moves* are examples of plans that reach across departments to develop comprehensive plans for non-motorized mobility. Through *Imagine Austin,* a cross-disciplinary task team was formed in 2013 (Personett 2013) to address green infrastructure issues, including those for multi-functionality, conservation, and recreation. Progress is documented through annual reports[71] to the comprehensive plan.
5. Utilize BRFSS data to promulgate policy. Interview respondents expressed concern for a lack of tools as well as empirical data for measurement of green infrastructure and physical activity. BRFSS data have been used successfully to promulgate policy and leverage funds in

[70] http://www.thecommunityguide.org/

[71] https://www.austintexas.gov/blog/way-forward-2015-imagine-austin-annual-report

support of physical activity at the state and local levels.[72] While there is a need to develop methods for data collection and measurement, existing BRFSS data offer a solution until more formalized methods and procedures are developed at the municipal level.

6. Formalize use of walkability audits and physical activity audits for planners and designers. Many audits have been developed as pre-development guidelines as well as post-occupancy evaluations, yet there is little information readily available to planners and designers. The Center for Active Design in New York published guidelines in 2010, and the Urban Design Checklist used in this study worked well to identify major elements and patterns for overall development on site. It was flexible and could be modified to address particular aspects at the project level. Combined with the Physical Activity Design Audit, components for physical activity onsite, as well as deficiencies were identified.

For the academic planner, my recommendation is to conduct research that builds new theory to advance green infrastructure and health. Green infrastructure literature offers little advancement in theory, especially as it relates to planning and implementation. From the pragmatist views of Schön (1983) and Forester (2012), reflective inquiry serves to advance knowledge in planning. I concur with Hack's description of Lynch's theory of urban design, "the best design theories were...developed out of necessity to solve a problem" (Hack 2015, 224). Having a better understanding of the planner's role in the process is needed to better situate the field in an

[72] http://www.cdc.gov/

interdisciplinary setting–not only how we situate planner within the institutional planning structure, but the role of the planner beyond that of facilitator among groups as a catalyst across disciplines. In this way the planner serves an important role to positively affect outcomes that promote public health and physical activity.

9.6 Next Steps

The breadth of this dissertation has provided me with a robust research agenda as my career continues to unfold and evolve. I intend to further pursue my commitment to conduct research to advance practice at the intersection of urban ecological, design, and public health with an emphasis to advance practice. More specifically, I plan to conduct case study research to more fully explore dimensions relative to the interface of stormwater management and 'ancillary' uses of green infrastructure in terms of co-occurrence of benefits and conflicts resulting from disciplinary perspectives and funding sources. My interest in the use of post-occupancy audits for physical activity will commence with a literature review of existing audits, and further pilot testing of the two used in my study to develop a tool to be used by practitioners to more fully integrate urban ecological infrastructure. Future study also includes comparison of design guidelines and post-occupancy audits to test the effectiveness of urban design guidelines to realize opportunities for physical activity.

This study highlights the need for research with regard to measurement of ecosystem services, particularly at the municipal scale. As cities develop metrics for performance, methods need to be developed to track progress in meeting stated health goals. Green infrastructure maintenance, especially the politics relative to disciplinary responsibilities and reluctance to engage innovative sustainable strategies calls for further study to develop effective models for practice.

9.7 Concluding Remarks

Environmental settings that produce a broad array of ecosystem services are referred to as multi-functional landscapes. They provide "multiple environmental, social, and economic functions in a given area of land, taking into account the interests of the landowners and users" (Lovell and Johnston 2009, 214). Through study of four cities at both the project and municipal scale, I have related the stories as well as documented successes and challenges experienced in creating multi-functional landscapes in support of physical activity. The role of the planners is viewed not only in terms of how planners are situated in the planning process; but, moreover, how planners can act as catalysts across disciplines to positively affect outcomes that that promote public health. While there are gaps and tensions between academy and practice, similarities also exist at the broadest level in which possibilities are discovered, what might work is analyzed in technical terms, and proposals are brought forth based on support from constituencies (Hack 2015). The incorporation of health in planning and the interaction with public health interests are key components to the future of ecosystem services in cities and metropolitan regions.

APPENDIX A: INTERVIEW OUTLINE/GUIDELINES

Interview Guidelines/Outline

The following is a list of questions to be asked in semi-structured interviews with persons from municipal agencies, special interest groups, elected officials, and practitioners. These include, but are not limited to the following areas of expertise: planning, landscape architecture, engineering, public health, and public administration. For the purposes of this study, the interview questions are structured in two tiers: 1) a conceptual level of understanding of policy, power and decision making; and 2) a practical level of project implementation in terms of what strategies are necessary for getting things done. The attitudes and perceptions of the actors and the processes employed are intended to inform those strategies. Responses to the questions are anticipated to inform opportunities and limitations to planning and implementation of green infrastructure for physical activity.

My methodological stance will be realistic, using the Appreciative Inquiry Approach (Flora and Flora, 2008) building on what is working to explore the issues. Use of appreciative inquiry methods involves the participants as co-learners to construct expert "know-what" with locally specific "know-how" knowledge (Flora and Flora 2008). This approach will be effective to obtain data and objectively analyze what is working and what is not in terms of trying to answer both conceptual and practical questions.

Five areas of inquiry have been developed to inform the content of the interviews. The following list provides a candidate list of questions by category to guide the interviews:

1. Identification of roles and responsibilities
    a. What is your position in the city, agency, or firm, etc. in which you are employed, affiliated with?
    b. How long have you been in this position?
    c. What are responsibilities of your position?
    d. How do your responsibilities relate to green infrastructure and physical activity?
    e. (project level only) What was your role in the project?

2. Familiarity of issues relative to green infrastructure and physical activity
    a. Green Infrastructure
        i. How is green infrastructure viewed in your city?
        ii. What level of importance is placed on green infrastructure in terms of projects and initiatives?
        iii. How does green infrastructure conceptualized, operationalized, implemented in your organization?

        iv. What strategies are most effective? What hasn't been so successful? Why?
        v. (Project level only) How was green infrastructure incorporated into the project?
    b. Physical Activity
        i. How does the term physical activity relate to health and green infrastructure?
        ii. What benefits do physical activity and green infrastructure share?
        iii. Are these benefits complementary? If so, how?
        iv. (project level only) What strategies were used to promote physical activity on site?
3. Public Health Promotion
    a. How does the public health department generally promote physical activity in the city?
    b. What programs are currently in place to promote healthy lifestyles and healthy eating in your city?
    c. Are promotions done entirely within the department? Who is responsible for the promotions?
    d. What is the level of support within the department for such initiatives?
    e. What are some of the specific programs and how do they work?
    f. Are there other departments involved in the development and implementation of such programs? If so, who and to what levels are they involved?
    g. (project level only)How was public health promotion addressed in the planning and design of the project?
4. Power and Collaboration
    a. Policy Issues
        i. How do current policies support or detract from promotional goals for physical activity and green infrastructure?
        ii. How does the greenprint/green infrastructure plan in your city promote physical activity and green infrastructure?
        iii. What policies should be implemented to support physical activity?
        iv. (Project level only) What policies and regulations supported development of green infrastructure on the project?
        v. (Project level only) Were there barriers to developing facilities that promote physical activity in terms of codes, policies, and/or regulations? If so, what were they?
    b. Collaborative Efforts
        i. What initiatives or programs in the city facilitate collaborative efforts among city stakeholders? Are they effective? Why or why not?"

ii. What ways would be most effective to encourage interdisciplinary collaboration for parks and recreation, public works, public health, etc., to promote physical activity?
iii. What items would you advocate on a transdisciplinary agenda to engage people in physical activity?
iv. What is the city's next step to facilitate (ongoing) collaboration?
v. (Project level only) Who were the key collaborators on the project, and what roles did they serve? How were issues concerning physical activity and green infrastructure addressed by the project team?

5. Scale and Measurement
    a. Performance Indicators
        i. What components should be measured for green infrastructure that promotes physical activity? Which are most important and why?
        ii. How important is the replicability of the project's best practices? Have they been replicated in other parts of the city? If so, where? If not, why not?
        iii. Does the project site connect to other sites and/or destinations?
        iv. Would measurements of best practices help your agency (firm, practice) promote policies that support green infrastructure that promotes physical activity? If so, how? If not, why not?

Reference: Flora, C. B. and J. L. Flora. 2008."The appreciative inquiry approach." In *Rural Communities: Legacy + Change.* Third Edition, 361-366. Boulder, CO: Westview Press.

Appendix B Field notes for Site Analysis

Summary of Field Work Notes
Summarized on May 30, 2015

What- field verification of site plans and municipal plan goals and objectives for multi-use landscapes to promote physical activity, assess how such landscapes utilize green infrastructure and integrate with other infrastructures to provide connectivity for physical activity.

How-Observation included three components: first bicycling through park (via Trek hybrid commuter bicycle) and its environs to assess ease of movement, connectivity, legibility, feeling of safety, and observations of multi-functionality on-site; repeat same exercise on foot to assess pedestrian system; and 3) photo documentation of site elements, both contributing and non-contributing to green infrastructure promoting physical activity.

Tools Used in Assessment:

- Lufkin wheel to determine constructed sidewalk and bikeway widths to determine consistency with same elements as delineated on plans.
- Physical Activity Audit Form (Winslow 2010): originally developed to inventory evidence of site strategies used to promote physical activity, it was used to detect such items, and relationship with green infrastructure elements: what green infrastructure elements were present and coinciding with site PA strategies.
- Center For Active Design Checklist for Urban Design: Although originally intended as a pre-design checklist for elements and strategies to promote active living, I wanted to use it in conjunction with the PA Inventory Form to see what elements and strategies had been implemented on site. A post occupancy evaluation could be useful on most projects, but few are rarely completed due to time and budget constraints. All sites did not contain all categories represented on the audit, but it was useful to ascertain how like elements were brought to fruition on site, and what associated elements were present or missing.

Mueller Austin

Site work conducted April 25-May 2, 2015
Status of development: Mueller is approximately 40 percent complete at time of site observation. Site was divided into the following segments:

1. Perimeter roadways
2. Interior Roadways
3. Northwest Greenway
4. Northeast Greenway
5. Southeast Greenway

6. Lake Park
7. Paggi Park
8. Ella Wooten Park

Lowry Denver

Site work conducted September 25-29, 2014

Status of development: Lowry is approximately 90 percent complete at time of site observation. Boulevard One currently under construction. Public Benefit Conveyance agreements for eastern parcels are still in effect, limiting future development.

Site was divided into the following segments for audit purposes:

1. Periphery roads
2. Major roads and boulevards
3. Great Lawn Park
4. Crescent Park
5. Bayaud Park
6. City of Ulaanbaatar Park
7. Mustang Park (maintained by LCMA)
8. Quantum Park (maintained by LCMA)

Waterfront Park, Louisville

Site work conducted April 9-12, 2015

Status of Development**:** Waterfront Park, developed in three phases over 15 years was completed in 2013. The Big Four Bridge was opened to Jeffersonville, Indiana in May 2014. A fourth phase of the park, not contiguous to existing Waterfront Park is currently in the planning stages.

Site was divided into eleven segments for fieldwork:

1. South Site Perimeter (Landward Boundary)
    a. River Road
    b. East Witherspoon Street
    c. Festival Plaza
2. Mayor's Miles
3. North and South Great Lawn (divided by Interstate 64)
4. Upland Orange Meadow and Play Area
5. Linear park and Upland Meadow (to purple parking area)
6. Lincoln Memorial and Swing Garden Area
7. Big Four Bridge Area + Louisville Loop
8. Water Play Area
9. Picnic Area/Adventure Playground
10. Amphitheater/Docks
11. Crew area

Vera Katz Eastbank Esplanade
Site work conducted December 13-14, 2014
Status of Development: Developed in two phases, each with two parts. Project is 100 percent complete.
Due to the linear nature of the park, park was not divided into individual segments.

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